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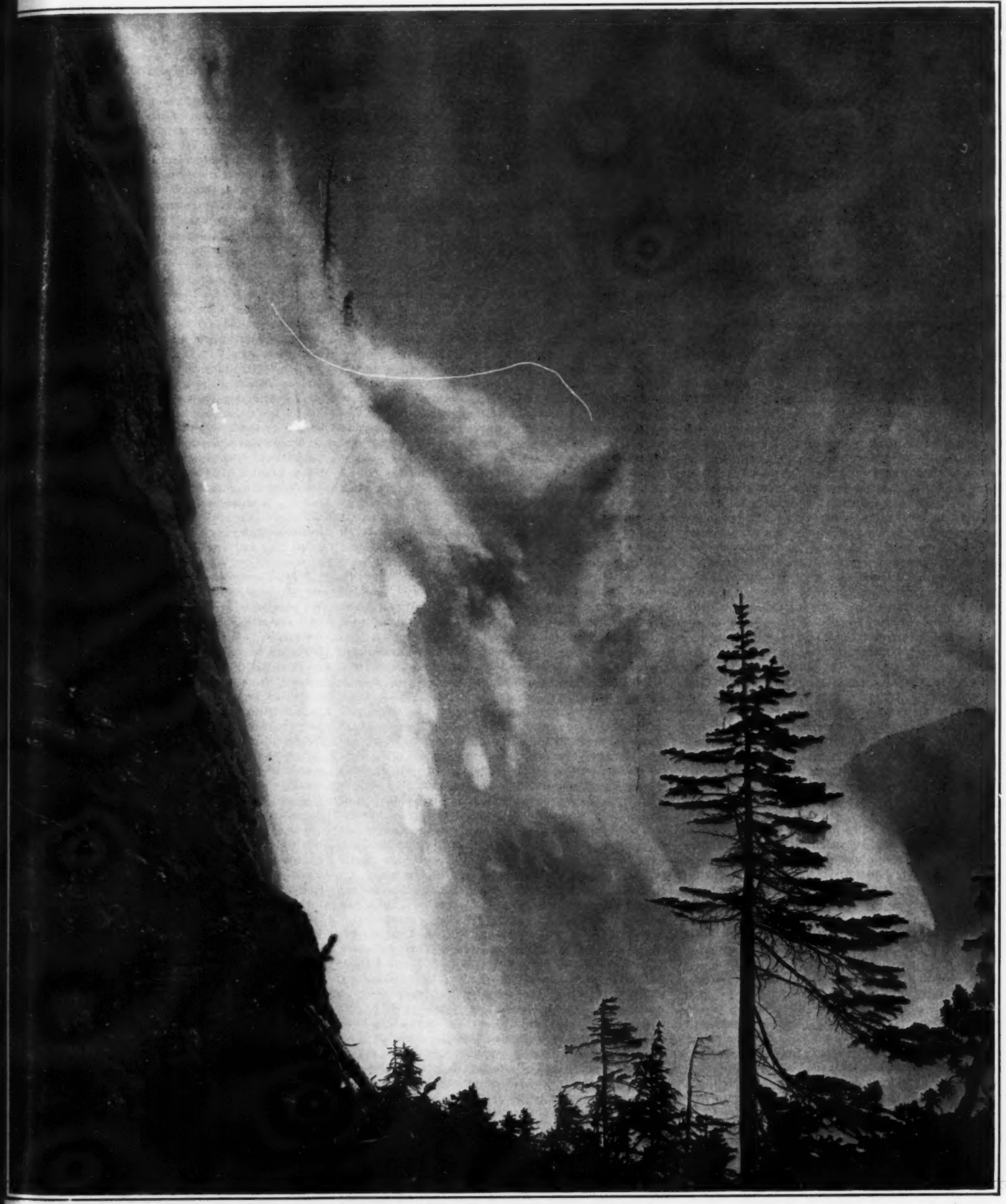


Emperor Falls, the outlet of Berg Lake to the Grand Fork River. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

THE PINNACLE OF THE CANADIAN ALPS.—[See page 183.]

Heredity—II*

New Theories and Facts Relating to the History of Organic Beings

By Prof. William Bateson

Continued from SCIENTIFIC AMERICAN SUPPLEMENT No. 2019, Page 171, September 12, 1914

IT was a commonplace of evolutionary theory that at least the domestic animals have been developed from a few wild types. Their origin was supposed to present no difficulty. The various races of fowl, for instance, all came from *Gallus bankiva*, the Indian jungle-fowl. So we are taught; but try to reconstruct the steps in their evolution and you realize your hopeless ignorance. To be sure there are breeds, such as black-red game and brown leghorns, which have the colors of the jungle-fowl, though they differ in shape and other respects. As we know so little as yet of the genetics of shape, let us assume that those transitions could be got over. Suppose, further, as is probable, that the absence of the maternal instinct in the leghorn is due to loss of one factor which the jungle-fowl possesses. So far we are on fairly safe ground. But how about white leghorns? Their origin may seem easy to imagine, since white varieties have often arisen in well-authenticated cases. But the white of white leghorns is not, as white in nature often is, due to the loss of the color elements, but to the action of something which inhibits their expression. Whence did that something come? The same question may be asked respecting the heavy breeds, such as Malays or Indian game. Each of these is a separate introduction from the East. To suppose that these, with their peculiar combs and close feathering, could have been developed from pre-existing European breeds is very difficult. On the other hand, there is no wild species now living any more like them. We may, of course, postulate that there was once such a species, now lost. That is quite conceivable, though the suggestion is purely speculative. I might thus go through the list of domesticated animals and plants of ancient origin and again and again we should be driven to this suggestion, that many of their distinctive characters must have been derived from some wild original now lost. Indeed, to this unsatisfying conclusion almost every careful writer on such subjects is now reduced. If we turn to modern evidence the case looks even worse. The new breeds of domestic animals made in recent times are the carefully selected products of recombination of pre-existing breeds. Most of the new varieties of cultivated plants are the outcome of deliberate crossing. There is generally no doubt in the matter. We have pretty full histories of these crosses in gladiolus, orchids, cineraria, begonia, calceolaria, pelargonium, etc. A very few certainly arise from a single origin. The sweet pea is the clearest case, and there are others which I should name with hesitation. The cyclamen is one of them, but we know that efforts to cross cyclamens were made early in the cultural history of the plant, and they may very well have been successful. Several plants for which single origins are alleged, such as the Chinese primrose, the dahlia, and tobacco, came to us in an already domesticated state, and their origins remain altogether mysterious. Formerly single origins were generally presumed, but at the present time numbers of the chief products of domestication, dogs, horses, cattle, sheep, poultry, wheat, oats, rice, plums, cherries, have in turn been accepted as "polyphyletic," or, in other words, derived from several distinct forms. The reason that has led to these judgments is that the distinctions between the chief varieties can be traced as far back as the evidence reaches, and that these distinctions are so great, so far transcending anything that we actually know variation capable of effecting, that it seems pleasanter to postpone the difficulty, relegating the critical differentiation to some misty antiquity into which we shall not be asked to penetrate. For it need scarcely be said that this is mere procrastination. If the origin of a form under domestication is hard to imagine, it becomes no easier to conceive of such enormous deviations from type coming to pass in the wild state. Examine any two thoroughly distinct species which meet each other in their distribution, as, for instance, *Lychnis diurna* and *vespertina* do. In areas of overlap are many intermediate forms. These used to be taken to be transitional steps, and the specific distinctness of *vespertina* and *diurna* was on that account questioned. Once it is known that these supposed intergrades are merely mongrels between the two species the transition from one to the other is practically beyond our powers of imagination to conceive. If both these can survive, why has their common parent perished? Why, when they cross, do they not reconstruct it instead of producing partially sterile hybrids? I take this example to show how entirely the facts were formerly misinterpreted.

When once the idea of a true-breeding—or, as we say, homozygous—type is grasped, the problem of variation becomes an insistent oppression. What can make such a type vary? We know, of course, one way by which novelty can be introduced—by crossing. Cross two well-marked varieties—for instance, of Chinese primula—each breeding true, and in the second generation by mere recombination of the various factors which the two parental types severally introduced, there will be a profusion of forms, utterly unlike each other, distinct also from the original parents. Many of these can be bred true, and if found wild would certainly be described as good species. Confronted by the difficulty I have put before you, and contemplating such amazing polymorphism in the second generation from a cross in *Antirrhinum*, Lotsy has lately with great courage suggested to us that all variation may be due to such crossing. I do not disguise my sympathy with this effort. After the blind complacency of conventional evolutionists it is refreshing to meet so frank an acknowledgment of the hardness of the problem. Lotsy's utterance will at least do something to expose the artificiality of systematic zoology and botany. Whatever might or might not be revealed by experimental breeding, it is certain that without such tests we are merely guessing when we profess to distinguish specific limits and to declare that this is a species and that a variety. The only definable unit in classification is the homozygous form which breeds true. When we presume to say that such and such differences are trivial and such others valid, we are commonly embarking on a course for which there is no physiological warrant. Who could have foreseen that the apple and the pear—so like each other that their botanical differences are evasive—could not be crossed together, though species of antirrhinum so totally unlike each other as *majus* and *molle* can be hybridized, as Baur has shown, without a sign of impaired fertility? Jordan was perfectly right. The true-breeding forms which he distinguished in such multitudes are real entities, though the great systematists, dispensing with such laborious analysis, have pooled them into arbitrary linnean species, for the convenience of collectors and for the simplification of catalogues. Such pragmatical considerations may mean much in the museum, but with them the student of the physiology of variation has nothing to do. These "little species," finely cut, true-breeding, and innumerable mongrels between them, are what he finds when he examines any so-called variable type. On analysis the semblance of variability disappears, and the illusion is shown to be due to segregation and recombination of series of factors on pre-determined lines. As soon as the "little species" are separated out they are found to be fixed. In face of such a result we may well ask with Lotsy, is there such a thing as spontaneous variation anywhere? His answer is that there is not.

Abandoning the attempt to show that positive factors can be added to the original stock, we have further to confess that we cannot often actually prove variation by loss of factor to be a real phenomenon. Lotsy doubts whether even this phenomenon occurs. The sole source of variation, in his view, is crossing. But here I think he is on unsafe ground. When a well-established variety like "Crimson King" primula, bred by Messrs. Sutton in thousands of individuals, gives off, as it did a few years since, a salmon-colored variety, "Coral King," we might claim this as a genuine example of variation by loss. The new variety is a simple recessive. It differs from "Crimson King" only in one respect, the loss of a single color-factor, and, of course, bred true from its origin. To account for the appearance of such a new form by any process of crossing is exceedingly difficult. From the nature of the case there can have been no cross since "Crimson King" was established, and hence the salmon must have been concealed as a recessive from the first origin of that variety, even when it was represented by very few individuals, probably only by a single one. Surely, if any of these had been heterozygous for salmon this recessive could hardly have failed to appear during the process of self-fertilization by which the stock would be multiplied, even though that selfing may not have been strictly carried out. Examples like this seem to me practically conclusive. They can be challenged, but not, I think, successfully. Then again in regard to those variations in number and division of parts which we call meristic, the reference of these to original cross-breeding is surely barred by the circumstances in which they often occur. There remain also the rare examples mentioned already in which a single wild origin may with much confidence be assumed. In spite of repeated trials, no one has yet succeeded in crossing the sweet pea with any other leguminous species. We know that early in its cultivated history it produced at least two marked varieties which I can only conceive of as spontaneously arising, though, no doubt, the profusion of forms we now have was made by the crossing of those original varieties. I mention the sweet pea thus prominently for another reason, that it introduces us to another though subsidiary form of variation, which may be described as a *fractionation* of factors. Some of my mendelian colleagues have spoken of genetic factors as permanent and indestructible. Relative permanence in a sense they have, for they commonly come out unchanged after segregation. But I am satisfied that they may occasionally undergo a quantitative disintegration, with the consequence that varieties are produced intermediate between the integral varieties from which they were derived. These disintegrated conditions I have spoken of as subtraction—or reduction—stages. For example, the Picotee sweet pea, with its purple edges, can surely be nothing but a condition produced by the factor which ordinarily makes the fully purple flower, quantitatively diminished. The pied animal, such as the Dutch rabbit, must similarly be regarded as the result of partial defect of the chromogen from which the pigment is formed, or conceivably of the factor which effects its oxidation. On such lines I think we may with great confidence interpret all those intergrading forms which breed true and are not produced by factorial interference.

It is to be inferred that these fractional degradations are the consequence of irregularities in segregation. We constantly see irregularities in the ordinary meristic processes, and in the distribution of somatic differentiation. We are familiar with half segments, with imperfect twinning, with leaves partially petaloid, with petals partially sepaloid. All these are evidences of departures from the normal regularity in the rhythms of repetition, or in those waves of differentiation by which the qualities are sorted out among the parts of the body. Similarly, when in segregation the qualities are sorted out among the germ-cells in certain critical cell-divisions, we cannot expect these differentiating divisions to be exempt from the imperfections and irregularities which are found in all the grosser divisions that we can observe. If I am right, we shall find evidence of these irregularities in the association of unconformable numbers with the appearance of the novelties which I have called fractional. In passing let us note how the history of the sweet pea belies those ideas of a continuous evolution with which we had formerly to contend. The big varieties came first. The little ones have arisen later, as I suggest by fractionation. Presented with a collection of modern sweet peas how prettily would the devotees of continuity have arranged them in a graduated series, showing how every intergrade could be found, passing from the full color of the wild Sicilian species in one direction to white, in the other to the deep purple of "Black Prince," though happily we know these two to be among the earliest to have appeared.

Having in view these and other considerations which might be developed, I feel no reasonable doubt that though we may have to forgo a claim to variations by addition of factors, yet variation both by loss of factors and by fractionation of factors is a genuine phenomenon of contemporary nature. If then we have to dispense, as seems likely, with any addition from without we must begin seriously to consider whether the course of evolution can at all reasonably be represented as an unpacking of an original complex which contained within itself the whole range of diversity which living things present. I do not suggest that we should come

* An address delivered at Melbourne, Australia, by Prof. William Bateson, M.A., F.R.S., President, before the British Association for the Advancement of Science.

[1] The numerous and most interesting "mutations" recorded by Prof. T. H. Morgan and his colleagues in the fly, *Drosophila*, may also be cited as unexceptionable cases.

to a judgment as to what is or is not probable in these respects. As I have said already, this is no time for devising theories of evolution, and I propound none. But as we have got to recognize that there has been an evolution, that somehow or other the forms of life have arisen from fewer forms, we may as well see whether we are limited to the old view that evolutionary progress is from the simple to the complex, and whether after all it is conceivable that the process was the other way about. When the facts of genetic discovery become familiarly known to biologists, and cease to be the preoccupation of a few, as they still are, many and long discussions must inevitably arise on the question, and I offer these remarks to prepare the ground. I ask you simply to open your minds to this possibility. It involves a certain effort. We have to reverse our habitual modes of thought. At first it may seem rank absurdity to suppose that the primordial form or forms of protoplasm could have contained complexity enough to produce the divers types of life. But is it easier to imagine that these powers could have been conveyed by extrinsic additions? Of what nature could these additions be? Additions of material cannot surely be in question. We are told that salts of iron in the soil may turn a pink hydrangea blue. The iron cannot be passed on to the next generation. How can the iron multiply itself? The power to assimilate the iron is all that can be transmitted. A disease-producing organism like the pebrine of silkworms can in a very few cases be passed on through the germ-cells. Such an organism can multiply and can produce its characteristic effects in the next generation. But it does not become part of the invaded host, and we cannot conceive it taking part in the geometrically ordered processes of segregation. These illustrations may seem too gross; but what refinement will meet the requirements of the problem, that the thing introduced must be, as the living organism itself is, capable of multiplication and of subordinating itself in a definite system of segregation? That which is conferred in variation must rather itself be a change, not of material, but of arrangement, or of motion. The invocation of additions extrinsic to the organism does not seriously help us to imagine how the power to change can be conferred, and if it proves that hope in that direction must be abandoned, I think we lose very little. By the re-arrangement of a very moderate number of things we soon reach a number of possibilities practically infinite.

That primordial life may have been of small dimensions need not disturb us. Quantity is of no account in these considerations. Shakespeare once existed as a speck of protoplasm not so big as a small pin's head. To this nothing was added that would not equally well have served to build up a baboon or a rat. Let us consider how far we can get by the process of removal of what we call "epistatic" factors, in other words those that control, mask, or suppress underlying powers and faculties. I have spoken of the vast range of colors exhibited by modern sweet peas. There is no question that these have been derived from the one wild bi-color form by a process of successive removals. When the vast range of form, size, and flavor to be found among the cultivated apples is considered it seems difficult to suppose that all this variety is hidden in the wild crab-apple. I cannot positively assert that this is so, but I think all familiar with mendelian analysis would agree with me that it is probable, and that the wild crab contains presumably inhibiting elements which the cultivated kinds have lost. The legend that the seedlings of cultivated applies become crabs is often repeated. After many inquiries among the raisers of apple seedlings I have never found an authentic case—once only even an alleged case, and this on inquiry proved to be unfounded. I have confidence that the artistic gifts of mankind will prove to be due not to something added to the make-up of an ordinary man, but to the absence of factors which in the normal person inhibit the development of these gifts. They are almost beyond doubt to be looked upon as *releases* of powers normally suppressed. The instrument is there, but it is "stopped down." The scents of flowers or fruits, the finely repeated divisions that give its quality to the wool of the merino, or in an analogous case the multiplicity of quills to the tail of the fantail pigeon, are in all probability other examples of such releases. You may ask what guides us in the discrimination of the positive factors and how we can satisfy ourselves that the appearance of a quality is due to loss. It must be conceded that in these determinations we have as yet recourse only to the effects of dominance. When the tall pea is crossed with the dwarf, since the offspring is tall we say that the tall parent passed a factor into the cross-bred which makes it tall. The pure tall parent had two doses of this factor; the dwarf had none; and since the cross-bred is tall we say that one dose of the dominant tallness is enough to give the full height. The reasoning seems unanswerable. But the commoner result of crossing is the production of a form intermediate between the two pure parental types. In such examples we see clearly enough that the full parental characteristics can only appear when they are homozygous—formed from similar germ-cells, and that one dose is insufficient to produce either effect fully. When this is so we can never be sure which side is positive and which negative. Since, then, when dominance is incomplete we find ourselves in this difficulty, we perceive that the amount of the effect is our only criterion in distinguishing the positive from the negative, and when we return even to the example of the tall and dwarf peas the matter is not so certain as it seemed. Prof. Cockerell lately found among thousands of yellow sunflowers one which was partly red. By breeding he raised from this a form wholly red. Evidently the yellow and the wholly red are the pure forms, and the partially red is the heterozygote. We may then say that the yellow is *YY* with two doses of a positive factor which inhibits the development of pigment; the red is *yy*, with no dose of the inhibitor; and the partially red are *Yy*, with only one dose of it. But we might be tempted to think the red was a positive characteristic, and invert the expressions, representing the red as *RR*, the partly red as *Rr*, and the yellow as *rr*. According as we adopt the one or the other system of expression we shall interpret the evolutionary change as one of loss or as one of addition. May we not interpret the other apparent new dominants in the same way? The white dominant in the fowl or in the Chinese primula can inhibit color. But may it not be that the original colored fowl or primula had two doses of a factor which inhibited this inhibitor? The pepper moth, *Amphidasys betularia*, produced in England about 1840 a black variety, then a novelty, now common in certain areas, which behaves as a full dominant. The pure blacks are no blacker than the cross-bred. Though at first sight it seems that the black *must* have been something added, we can without absurdity suggest that the normal is the term in which two doses of inhibitor are present, and that in the absence of one of them the black appears.

In spite of seeming perversity, therefore, we have to admit that there is no evolutionary change which in the present state of our knowledge we can positively declare to be not due to loss. When this has been conceded it is natural to ask whether the removal of inhibiting factors may not be invoked in alleviation of the necessity which has driven students of the domestic breeds to refer their diversities to multiple origins. Something, no doubt, is to be hoped for in that direction, but not until much better and more extensive knowledge of what variation by loss may effect in the living body can we have any real assurance that this difficulty has been obviated. We should be greatly helped by some indication as to whether the origin of life has been single or multiple. Modern opinion is, perhaps, inclining to the multiple theory, but we have no real evidence. Indeed, the problem still stands outside the range of scientific investigation, and when we hear the spontaneous formation of formaldehyde mentioned as a possible first step in the origin of life, we think of Harry Lauder in the character of a Glasgow schoolboy pulling out his treasures from his pocket—"That's a wassher—for makkin' motor cars"!

As the evidence stands at present all that can be safely added in amplification of the evolutionary creed may be summed up in the statement that variation occurs as a definite event often producing a sensibly discontinuous result; that the succession of varieties comes to pass by the elevation and establishment of sporadic groups of individuals owing to their origin to such isolated events; and that the change which we see as a nascent variation is often, perhaps always, one of loss. Modern research lends not the smallest encouragement or sanction to the view that gradual evolution occurs by the transformation of masses of individuals, though that fancy has fixed itself on popular imagination. The isolated events to which variation is due are evidently changes in the germinal tissues, probably in the manner in which they divide. It is likely that the occurrence of these variations is wholly irregular, and as to their causation we are absolutely without surmise or even plausible speculation. Distinct types once arisen, no doubt a profusion of the forms called species have been derived from them by simple crossing and subsequent recombination. New species may be now in course of creation by this means, but the limits of the process are obviously narrow. On the other hand, we see no changes in progress around us in the contemporary world which we can imagine likely to culminate in the evolution of forms distinct in the larger sense. By intercrossing dogs, jackals, and wolves new forms of these types can be made, some of which may be species, but I see no reason to think that from such material a fox could be bred in indefinite time, or that dogs could be bred from foxes.

Whether science will hereafter discover that certain groups can by peculiarities in their genetic physiology be declared to have a prerogative quality justifying their recognition as species in the old sense, and that the differences of others are of such a subordinate degree that they may in contrast be termed varieties, further genetic research alone can show. I myself anticipate that such a discovery will be made, but I cannot defend the opinion with positive conviction.

Somewhat reluctantly, and rather from a sense of duty, I have devoted most of this address to the evolutionary aspects of genetic research. We cannot keep these things out of our heads, though sometimes we wish we could. The outcome, as you will have seen, is negative, destroying much that till lately passed for gospel. Destruction may be useful, but it is a low kind of work. We are just about where Boyle was in the seventeenth century. We can dispose of Alchemy, but we cannot make more than a quasi-chemistry. We are awaiting our Priestley and our Mendeléeff. In truth it is not these wider aspects of genetics that are at present our chief concern. They will come in their time. The great advances of science are made like those of evolution, not by imperceptible mass-improvement, but by the sporadic birth of penetrative genius. The journeymen follow after him, widening and clearing up, as we are doing along the track that Mendel found.

(To be continued.)

Ozone in the Upper Atmosphere

ACCORDING to J. N. Pring, in the *Proceedings* of the Royal Society, ozone can be distinguished from nitrogen oxides in very dilute gas mixtures with the aid of an aqueous solution of potassium iodide, provided the temperature does not fall below the freezing point of the reagent — 240 deg. Cent. Hydrogen peroxide would give the same reaction as ozone, but can be distinguished from it by the titanium sulphate test. The action of ultra-violet light on air is studied in a bulb, immediately surrounding the quartz tube of the mercury lamp, so that the rays pass through the quartz walls directly into the air; the whole apparatus is immersed in water. The arc is started with the aid of an induction coil, after joining the lamp terminals to a source of current at 100 or 200 volts; the secondary of the coil is also connected with one of these terminals, and, further, with a wire wrapped round the annular jacket of the lamp; the coil is worked until a glow discharge, followed by the arc, is seen in the lamp. In this apparatus no nitrogen oxides nor hydrogen peroxides were produced; the ozone production decreased when the gas pressure was reduced, from 0.01 per cent at 760 millimeters to 0.0014 per cent at 30 millimeters. With the absorbing vessels of Hayhurst and the author, atmospheric measurements were conducted in the Alps at altitudes between 2,000 and 3,500 meters. Free balloon measurements were made from Manchester. In the Alps the mean quantity of ozone found in one volume of air was 2.5×10^{-6} at 2,100 meters, and 4.7×10^{-6} at 3,580 meters; the amount did not increase much at higher altitudes up to 20 kilometers; the ozone contents fluctuated; nitrogen oxide and hydrogen peroxide were not observed in the upper atmosphere. The amount of ozone stated sufficed, as laboratory experiments indicated, to impart a blue color to the gas; thus ozone would contribute to the blue color of the sky.

Production of High Vacua by Means of Finely Divided Copper

T. R. MERTON says in the *Journal* of the Chemical Society: Finely divided copper which may be obtained by reducing a solution of a copper salt and is sold commercially as "precipitated copper," absorbs gases with great readiness, the vapor pressure of the gases thus absorbed being so small that under suitable conditions it may be used for the production of high vacua. A bulb containing a few grammes of the copper is sealed to the vessel to be exhausted, the vessel being then partially exhausted by means of an air pump and the copper heated to about 250 degrees. When the air pump is disconnected and the copper allowed to cool, the residual gases are rapidly absorbed. This absorption is not due to chemical combinations, since the gases are liberated when the copper is heated. The carbon bands disappear first, then nitrogen, and finally hydrogen, but helium does not appear to be absorbed appreciably. Diminution in the absorbing power of the copper follows (1) the use of an excessively high temperature, (2) repeated use, or (3) prolonged exposure to the mercury-vapor from a mercury lamp. Great care is necessary when the copper is being used for the first time, as the occluded gases may sometimes be evolved with such violence that the copper is blown through into the pump; consequently not more than one third of the bulb should be filled with copper, and a short length of the tube connecting the bulb and the pump should be tightly packed with glass wool.

A New Application of Roentgen Rays*

An Infallible Means for Identifying Oil Paintings

A ROENTGEN ray image, or radiograph, of an oil painting resembles a rough sketch, rather than a photograph of the picture. The relative brightness of the colors is altered, the outlines are often displaced, and ugly spots and bands mar the general effect. These changes require a few words of explanation.

In a radiograph of the human body, the differences of brightness that distinguish the heart from the lungs, bone from flesh, etc., are due to differences in density of the various tissues. In a radiograph of an oil painting similar effects are produced by differences in density of the pigments, and especially by the atomic weight of their principal or heaviest elements, the influence of which may even reverse the effect of greater or less dilution with oil.

A scale of oil colors, arranged in accordance with their transparency to Roentgen rays, can be made by applying standard pigments to canvas in patches of equal thickness. When the direct, or negative, radiograph of a canvas thus painted is compared with its positive photograph, printed from a negative made by an orthochromatic process, a general resemblance is observed, but the gradation in tint, which has been made regular in the radiograph by the arrangement of the pigments, is strikingly irregular in the photograph. The comparison is made between the negative radiograph and the positive photograph because, in general, those pigments that are heaviest, or that contain elements of highest atomic weight, are lightest in color. In the negative radiograph that constitutes the Roentgen scale, light tints are produced by white, yellow, and red pigments (except the vegetable colors, Indian yellow and madder), medium tints by the greens and browns, and dark tints by all blues, blacks, and lakes.

It is evident, therefore, that juxtaposed pigments must reveal themselves, to some extent, in the radiograph of an oil painting. In the case of superposed pigments experiment confirms the theoretical conclusion that a design drawn in a heavy pigment will, in the radiograph, show through a superposed uniform layer of a less dense pigment, as bones show through flesh, while a design in pigment of low density will be almost completely masked by a superposed uniform coat of heavy pigment. The results are the same when the uniform layer underlies the design, for the tint of the radiograph is due to the summation of the opacities (to Roentgen rays) of all of the superposed layers.

In this summation, however, a heavy pigment outweighs even a medium pigment of thrice its thickness. Furthermore, dark colors are usually laid on thinly, while the heavy white and yellow pigments are applied very thickly, so that they are still more strongly contrasted in the radiograph.

In short, an ordinary photograph reproduces only the surface of a painting, while a radiograph represents the projection of all of the superposed pigments, which produce effects in proportion to their densities. The grain of the canvas or wood shows likewise, but no appreciable effect is produced by a ground of paper or canvas, or by a coat of varnish.

Let us now consider the practical results that can be obtained from the examination of oil paintings with Roentgen rays. The first picture that I examined in this way was a "Lucretia," attributed to an Italian artist of the seventeenth century. I did not succeed in finding the signature I sought, but I made several interesting discoveries, which are illustrated in the accompanying photographs and radiographs. The flesh tones of the painting are very lifelike, especially in the neck, bosom, and shoulders. The figure reclines against a golden brown curtain, which contrasts but slightly with the chestnut hair, dark green bodice, and dark brown robe, while the steel dagger, with its gold-bronze hilt, stands out conspicuously from the yellowish-white frill of the opened chemise.

Radiograph.

Photograph.

Bust of "Lucretia."

The radiograph shows an irregular light area in place of the dark bodice, the frill of the chemise appears torn and indistinct, and the blade of the dagger is lengthened.

"Lucretia," attributed to a seventeenth century Italian artist. (Photograph.)

In the photograph this frill is sharply defined and clearly distinguished from the bodice, but in the radiograph it appears tattered and it overflows the bodice, the greater part of which, indeed, is replaced by a broad strip of nearly the hue of the frill. This leads me to suspect that the bodice was added as an afterthought, perhaps to diminish the area of white, and that the white chemise shows through it in the radiograph, for reasons already explained. The sharp white band below the dagger in the radiograph may indicate an alteration in the position of the weapon, the blade of which is a little longer than it is in the photograph.

The radiograph of the right hand shows a broad light band, which runs obliquely from the upper left corner to and beyond the table, and of which not a trace is discernible in the photograph or the painting. This may indicate a fold of the gown, subsequently altered, but it more probably represents the first rough sketch of the arm and hand. The narrow light band, parallel to the edge of the table, is faintly visible in the painting.

In the radiograph the third and little fingers are close together and a supernumerary finger appears between the index and middle fingers. From these and other differences I infer that the hand hung limp with the fingers nearly in contact in the first sketch, and that the fingers were afterward separated.

The most striking feature of these radiographs is their revelation of details of the first sketch, which have been altered in the finished picture. Thus we obtain an insight into the methods of an artist who has been dead for centuries. Information of a different sort is obtained by comparing the radiograph and the photograph of our Lucretia's head and shoulder. The picture was "restored" some twenty years ago, and the subsequent changes of tint of retouched parts of the face and shoulder are visible in the painting and, to some extent, in the photograph. The radiograph, however, clearly shows the flaking that led to the restoration. When the painting is examined by the transmitted light of a 32 candle-power metallic filament lamp, some of the flaked parts appear, less distinctly than in the radiograph, while others are quite invisible. Ordinary light reveals no trace of the long crack on the shoulder, which evidently was filled with a thick mass of pigment containing too little white lead to obliterate the crack, in the radiograph. The white spots above the ear probably indicate an excess of white lead used in retouching. At all events radiography appears to supply an excellent method of detecting alterations in oil paintings, although in some cases it leaves room for doubt whether the changes were made during the construction of the picture, or subsequently.

Although I could discover no signature on the Lucretia, probably because the picture was not signed, I found traces of a signature on another painting—

* Adapted from Dr. Alexander Faber's article in *Umschau*.

Radiograph.

Photograph.

Head and shoulders of "Lucretia."

The radiograph shows flaked spots of picture before restoration.

C. Sell's "Brigands"—where I was not looking for one, because the artist's name was written plainly, in small red letters, in the lower right-hand corner. (These letters are barely discernible in either the photograph or the radiograph, and are quite invisible in the reproductions here shown.)

At the bottom of the radiograph, farther toward the left, I discovered traces of a much larger *C* and *S*, which did not appear in the photograph or the painting. Between these two letters were marks which I could not make out.

I infer that the artist first signed his picture with large initials, altered them a little, and then covered them with the greenish brown ground color, and wrote a smaller signature in the corner. This discovery shows the possibility of detecting by radiography a signature that has been painted over. The detection is easier in proportion to the density of the pigment used for the signature and the lack of density of the superposed coat.

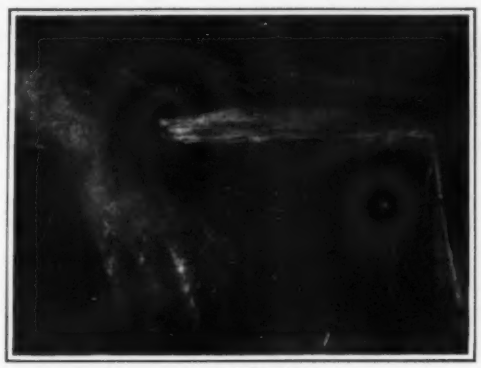
The "Brigands," which is painted thinly on wood, yields little additional radiographic booty. The sky, calm in the painting, is stormy in the radiograph. The grain of the oak panel, clearly visible in the radiograph, accounts for much of the difference, but there are indications of a large white cloud, subsequently painted over.

The two white bands above the head of the robber chieftain were produced by strips of plaster employed to support the panel in making the radiograph. This shows the necessity of cleaning the backs of pictures before they are radiographed.

The radiographs which are here reproduced and discussed illustrate the peculiar value of radiography as a means of identifying oil paintings. The possessor of a radiograph of even a part of a valuable picture, showing the layers of pigment that are hidden from the eye, and the changes made during the composition of the work, can easily distinguish the genuine picture from spuries copies, for it is practically impossible even for an imitator skilled in radiography to make a copy that will stand the Roentgen ray test.

There is another possible inference which I put forward merely as a hypothesis. The radiograph of an original picture usually reveals changes made by the artist in the course of his work. The counterfeiter, like other copyists, reproduces as accurately as possible the final result, which is all that he sees. He also makes errors and corrects them, but his corrections are different from those made by the artist, and serious changes in composition would scarcely be made in the process of constructing a counterfeit. Hence in deciding between rival claims to authenticity, the preference should be given to that picture whose radiograph reveals the greatest and most characteristic changes in composition. It is possible that such disputes, which have continued for centuries in regard to many paintings, can be decided by radiography. The authenticity or antiquity of an uncopied picture may also be decided, apart from the possible detection of a signature, by the radiographic revelation of characteristic methods of working and, in many cases, of characteristic pigments.

It appears, therefore, that the radiographic method, which I have applied with thoroughness to only four paintings, is well worthy of further study and development. In art, as in medicine, it is not an infallible and universally applicable means of diagnosis, and it should be used in conjunction with other approved methods.

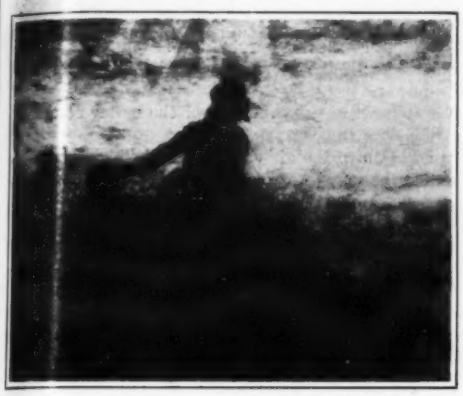


Radiograph.

Photograph.

Hand of "Lucretia."

The broad light band running from the upper left hand corner of the radiograph probably indicates the first sketch of the arm and hand, and the extra finger between the middle and forefinger marks the original position of the forefinger.



"Brigands," by C. Sell. (Radiograph.)

"Brigands," by C. Sell. (Photograph.)

Radiograph.

Photograph.

A modern flower piece.

The thickly laid on pigments produce very strong contrasts in the radiograph.

New Light on Ancient Egypt

SOME of the results of recent exploration in the Nile Valley were described by the Rev. Prof. Sayce, at a meeting of subscribers to the Egypt Exploration Fund at the rooms of the Royal Society.

At Abydos Prof. Naville had discovered the famous temple of Osiris, as he believed, and another colossal monument of Egyptian antiquity had been added to what were already known. It reminded students that the history of Egyptian architecture, as it was known, was one of decadence. Apart, however, from Abydos and the work of Petrie, the chief discoveries of the past season had been made, not in Egypt, but in the Soudan. At Kerma, a little south of the third cataract, Dr. Reisner was changing all accepted ideas of early Soudanese history. He had shown that as early as the fifth and sixth dynasties the northern Soudan was occupied by Egyptian troops, and that trade was carried on from the Blue Nile to the Red Sea, and thence throughout the Orient.

Prof. Garstang, investigating at Meroe, below the sixth cataract, had found an observatory at the bottom of an underground bathing establishment. On the walls were the astronomer's calculations. An African Pompeii had been brought to light. The ruins covered a considerably larger area than those of Memphis, and included a Royal city surrounded by magnificent walls, 15 feet thick in places, with two palaces, public baths, and gymnasia, as well as many streets and private dwellings. The main streets were bordered by trees, for which pits lined with brick had been sunk, and on the riverside walls, quays, and landing stages. The town was the Birmingham and the Liverpool of ancient Africa. It was the center of the iron industry, the smelting furnaces of which had been unearthed, and enough metal was worked there to supply the whole of Northern Africa. Among the most beautiful objects found were cups and bowls of biscuit ware as hard and fine and thin as the egg-shell ware of China, but not translucent. The biscuit ware of China was not older than 200 A.D., while that of Meroe dated from the third or second century before Christ. It was known that the Chinese made trading voyages as far as Abyssinia, and that pottery was among the articles of commerce, so that it was allowable to conclude that they copied the Meroe ware which had been carried by the trade routes to the Red Sea and thence to China.

Lord Carnarvon and Mr. H. Carter had found at Thebes the lost tomb of Amon-hotep. Last year Dr. Borchardt discovered at Tel-el-Amarna the workshop of a sculptor, from which had come the heads of two princesses worthy of being placed side by side with the finest specimens of Greek work. This year the excavations had yielded two cuneiform tablets. One of them was part of a dictionary bearing a list of words in at least two languages. The other was the first example of a political treaty in existence—a treaty between the Egyptians and the Hittites, at the beginning of the Hittite empire. All the discoveries showed that ancient Egypt by trade, war, and diplomacy had relations with the countries around her. The civilized world of the ancient East was not so very much unlike the civilized world of to-day. We stood much nearer to the men of old Egypt than to the half-civilized Europe of the Middle Ages, and we should find ourselves far more at home with them than with the Crusaders who sacked Byzantium.

Lord Grenfell, who presided, recalled the interest taken by the British officers of the Nile Expedition in the remains of the old temples and fortifications. On one occasion he was wrecked on an island in the river, and found most comfortable and hospitable shelter for a day and a night in one of them. He was quartered for two years at Assouan, and it was his good luck to open tombs of the third, sixth, and twelfth dynasties. All Egyptologists were grateful for the support and protection afforded them by Sir R. Wingate, the Sirdar.—*The Daily Telegraph.*

Tractor Biplanes for the United States Army

Conditions Governing a Contest to be Held at the Signal Corps Aviation School at San Diego, California, on or about October 15, 1914

As a result of the $250,000 appropriated for aviation in the army, $30,000 of which is immediately available, the following contest has been announced.

The type desired, namely, a military reconnaissance aeroplane, must possess the following characteristics: Biplane, enclosed fuselage, two seater, dual control, having a maximum speed of not less than seventy and a minimum speed of not more than forty miles per hour when carrying fuel and oil for four hours' flight at seventy miles per hour and a useful load of 450 pounds, and under these conditions of load, being capable of climbing 4,000 feet in ten minutes. All parts of the aeroplane shall be of first-class material and workmanship throughout. The head resistance is to be kept down by avoiding unnecessary parts exposed to the wind, and by using recognized stream lines for those parts necessarily exposed. The power plant is to be located in front of the occupants and suited to the requirements of the aeroplane. The motor must be capable of throttling to 20 per cent of full speed and running without overheating over the land. The motor must be supplied with a positive means of stopping by a short-circuiting device, by release of compression, or by other suitable means. It is desirable that the radiators, if used, should conform to stream line requirements and act as an effective shelter for the motor. The motor should be provided with positively driven pump for pumping gasoline from the reservoir to the service tank and will also be provided with attachments for hooking on a flexible tachometer, the shaft for this purpose to come off the motor at right angles to the propeller shaft, preferably downward. The propeller, or propellers, should be of efficient form and construction and suited for the particular machine and possessing a minimum efficiency of 70 per cent, that is to say, to have a slip of not over 30 per cent. The controls should be of such a type as approved by the Chief Signal Officer of the Army. During the trials, the builder may use such controls as are familiar to his demonstrator, but the Signal Corps design shall be substituted at the builder's expense prior to delivery and acceptance of any machine acquired as a result of this competition. Wear and friction in the control leads must be eliminated in every possible way, and the leads shall be as direct as possible. Leads to pitching and steering shall be in duplicate. The landing gear should be as strong and simple as possible, to be efficient in absorbing shocks in landing and running at full speed over rough and plowed ground. The maximum gliding angle shall under no condition exceed 1 in 6, that is to say, one foot of drop for each six feet of advance. All parts shall be efficiently protected from the action of the weather by the use of suitable paint or furnished with covers. The power plant shall be so arranged as to be readily removed and replaced bodily without disturbing the alignment or the fastenings of the planes or landing gear. The machine complete shall be capable of being assembled from transportation cases in not to exceed two hours by four mechanicians, and of being disassembled and packed in transportation cases in not more than one hour and a half by the same number of mechanicians. No part shall be of such length that when packed the case shall exceed twenty feet in length.

The manufacturers who desire to enter this competition shall inform the Chief Signal Officer of the Army on or before September 1st, 1914, of this fact in writing, and shall supply the President of the Board of Officers, who will conduct the tests, the following data on or before October 1st, 1914:

(*a*) Weight, fully loaded when fully equipped.
(*b*) Normal angle of incidence in horizontal flight.
(*c*) Gliding angles.
(*d*) Safe ranges of angle of incidence.
(*e*) Fuel, oil, and water consumption with certificate of performance (subsequently described).
(*f*) Blueprint or diagram to scale of aeroplane and motor complete.
(*g*) Stress diagram of planes showing tensile and bending stress on beams, struts and brace wires, clearly indicating the material used and the factor of safety in each member, together with moment diagrams.
(*h*) Itemized weight of parts.

The certificate of performance shall consist in a certified test of the motor as follows:

1. One hour run at the rated brake horse-power on the test stand.
2. Half hour run at the maximum power on the stand.
3. A run of half an hour at 20 per cent of the rated revolutions per minute

During the test, the following data shall be reported:

Revolutions per minute at the rated brake horse-power.

Revolutions per minute at maximum brake horse-power.

Minimum revolutions per minute.

The oil per brake horse-power and the fuel per brake horse-power.

A statement of the condition of the motor at the end of a half hour run.

In addition to the above data, the following information shall be noted on the certified test sheet to accompany each motor:

The maker's number, horse-power, stroke, diameter of shaft, piston displacement, type of magneto, type of tachometer used in test, weight complete, starting arrangement, carbureter (trade name), cooling system, lubricating system, type of spark plugs used, date and place of test, the type, pitch, number of blades and blade area of the propeller or propellers used, and if geared down, the ratio of gearing.

The machines entering the competition must be delivered on the ground of the Signal Corps Aviation School, at San Diego, Cal., on or before October 20th, 1914, at the manufacturer's expense. Each manufacturer shall supply a demonstrator. The Signal Corps will provide suitable housing for the machines, and the fuel and oil for the tests. The competitive test will be conducted by a Board of Officers to be appointed by the Chief Signal Officer of the Army under the detailed rules which are given below.

To enter the competition, each machine must qualify by demonstrating by actual trial that it complies with the above requirements by making a non-stop flight of four hours in the air, and by making the climb, fully loaded, of 4,000 feet in ten minutes. The machines will be graded by points, taking into consideration the following:

Construction and workmanship; speed, maximum and minimum; climbing and maneuvering ability; ease of handling; gliding angle; inherent stability; suitability of landing gear, distance of run on the ground when starting and landing; field of vision, etc.

If five or more machines qualify, the Signal Corps will purchase the three which make, in order, the greatest number of points; the first for $12,000, the second for $10,000, and the third for $8,000. If but three or four qualify, the first two will be purchased at $12,000 and $10,000, respectively. If but two qualify, the one making the highest number of points will be purchased at $12,000.

All inquiries concerning this competition should be addressed to the Chief Signal Officer of the Army, Washington, D. C.

THE GENERAL RULES AND SCHEDULE OF POINTS FOR THE COMPETITION FOLLOW:

All tests shall be made with a pilot, passenger, and sufficient dead load to make the total of 450 pounds of useful weight in addition to fuel and oil sufficient for 4 hours' flight.

All tests will be made at times to be specified by the Board.

Air-brakes, means of locking wheels, etc., will be allowed in all landing tests.

All landings shall be made normal.

In the speed tests, a practically uniform height above the ground must be maintained by pilot from the time he crosses the starting line until after he passes the finishing line.

In case a competitor takes his full number of trials, he will be given credit for the best performance, not the average of the trials.

Any questions that may arise which are not covered by the above will be determined by the Board of Officers conducting the test, whose decision shall be final.

No.	Point.	Required.	Value.	How determined.	Number of trials allowed.	
1	Construction and workmanship...	.....	200	Practical examination by Board, study stress diagrams, etc.	.....	
2	Speed, maximum..	70 M. P. H.	100	Over measured course three flights each way.	3	For speeds in excess of 70 M. P. H additional points will be given at rate of four points per mile over.
3	Speed, minimum..	40 M. P. H.	100	Over measured course, three flights each way.	3	For speeds below 40 M. P. H. additional points will be given at rate of two points per mile under.
4	Climbing.....	4,000 feet in ten minutes	100	Flying start, competitor to fly parallel to ground and close to it before attempt.	3	For each 100 feet over 4,000, covered in 10 minutes climb, competitor will be allowed 5 points additional.
5	Suitability of landing gear.....	.....	100	Maneuvering on ground under power, starting from and landing in plowed and rough ground.	.....	Best machine will be given perfect score, others rated accordingly.
6	Gliding angle.....	Minimum 1 on 6.	75	After flying level at specified height, competitor will cut engine out at given signal and descend in given direction.	3	Ten points for each additional foot in excess of that required, namely, 6 feet of advance for 1 foot descent.
7	Inherent stability..	.....	75	Theoretically and practically.	.....	Best machine will be given perfect score, others rated accordingly.
8	Ease of maneuvering in air.....	.....	50	The Board will prescribe certain evolutions to competitors.	.....	Best machine will be given perfect score, others rated accordingly.
9	Field of vision....	.....	50	From practical observation of military observer.	.....	Best machine will be given perfect score, others rated accordingly.
10	Ease of assembly..	2 hours, 4 men.	25	Practical test on field.	.....	Best machine will be given perfect score, others rated accordingly.
11	Ease of disassembly	1½ hours, 4 men.	25	Practical test on field.	.....	Best machine will be given perfect score, others rated accordingly.
12	Ease of installation and repair motor, etc.....	.....	25	Practical test on field.	.....	Best machine will be given perfect score, others rated accordingly.
13	Landing over 30 foot obstacle and pulling up in field beyond.....	.....	25	Practical test on field.	3	Best machine will be given perfect score, others rated accordingly.

Iron Shielded from Earth's Magnetism

In the *Proceedings* of the Royal Society an account is given of experiments made by E. Wilson on a ring specimen of stalloy built up from stampings and a magnetic shield formed from stampings of transformer iron. The specimen was supported symmetrically within the shield, and the common axis placed at right angles to the magnetic meridian. Measurements taken ballistically with the ring shielded and unshielded show that the earth's magnetism may seriously affect the magnetizability of iron.

Comparing the results obtained when stalloy was magnetized and then demagnetized, with the results of similar experiments on the same material demagnetized but exposed to the earth's magnetism, the ratio of the permeabilities had a maximum of 1.79 when B was 172, and the ratio of the maximum permeabilities was 1.24. The maximum μ for the shielded specimen was 5,900. The dissipation of energy by hysteresis was less when the stalloy was demagnetized in the shield than when demagnetized and then exposed to the earth's magnetism. The Steinmetz index, after rising to a maximum of about 3 for a force of about 0.008 C.G.S., begins to diminish as the force is reduced, and at about this point the hysteresis loops tend to become parallel straight lines.

The Pinnacle of the Canadian Alps

The Opening of a New American Scientific Storehouse

By Carl Hawes Butman, Smithsonian Institution

FOLLOWING the much reiterated slogan of American railroad and steamboat lines, "See America first," it seems pertinent to extol the characteristics of a part of this continent only recently explored, but in the near future to be opened for the inspection of its scenic wonders, comprising mountain ranges, peaks, glaciers, rivers, lakes, and waterfalls of exceptionally wild grandeur and romantic beauty. There are features which are calculated to surprise and interest even the most *blasé* tourist, scientist, or artist. The region referred to is that portion of the Rocky Mountains lying, unfortunately, just outside our border, in the territories of British Columbia and Alberta, Canada, and known as the Robson Peak District.

The majestic mountain from which this district takes its name, originally called Robson Peak by Milton and Cheadle in 1865, but later designated Mount Robson, has now been renamed Robson Peak by Dr. Charles D. Walcott, secretary of the Smithsonian Institution. It stands in the very heart of a severely cold and rugged country unbroken by trail or blaze, amid the most vivid and diversified natural scenery, surrounded by a number of massive, though less lofty, mountain ranges and peaks, and thrusts its rocky spire upward through glaciers, icefields, and even the clouds, to a height of 13,068 feet above the sea. Although it is only about eighth in height in America, it is the highest point on the Continental Divide in Canada, and has been aptly termed "The Monarch of the Canadian Rockies" by Dr. Walcott in both his descriptive and technical reports upon his investigations in this locality.

This gigantic peak is located thirty-two miles west-northwest of Yellowhead Pass on the Continental Divide, and just six miles north of Fraser River and the Mount Robson station on the Grand Trunk Pacific Railway. It locates the center of a section of Canadian territory twenty miles in diameter, which is soon to be opened to explorers and travelers. One gateway to this veritable wonder-land is already open from Edmonton, Alberta, *via* the Grand Trunk to Mount Robson station, which affords the sightseer a view of the Peak itself, only six miles distant. Already Robson, with its approaches, has been roughly explored and mapped by the Alpine Club of Canada, which plans to establish its next summer camp at the foot of Robson on the shores of Berg Lake, in the clear and cool atmosphere attending a 5,500 foot elevation. Soon, undoubtedly, it will be no uncommon sight to see many tourist parties tramping over the great ice fields and scaling the stony mountain sides, for it is thus, practically in a night, that the American recreation and outdoor loving populace seize upon opportune moments to be early on the scene of a newly opened playground.

Robson Peak was virtually unknown, except to a few venturesome hunters and trappers, until about 1909, when Dr. A. P. Coleman wrote a graphic description of its grandeurs and related his attempts to scale its scarcely pregnable ramparts, although as early as 1865 Milton and Cheadle, two English explorers, made mention of it in their article, "The Northwest Passage by Land," and later McEvoy and Kinney told of this great Canadian peak and the country surrounding it.

Others have since visited the region and have also attempted a description of this ice and snow clothed mountain and its remarkable and wonderful Alp-like environs, but like most of those who have essayed to chronicle the virtues of the Grand Canyon of Arizona, they have failed; it is well nigh impossible to do such scenery justice.

One of the most inspiring and spectacular scenes in the world may be witnessed from the slopes of the peaks and mountains surrounding Robson, particularly from a great ridge south of Mumm Peak at an elevation of about 1,800 feet above Robson Pass, where an extensive view of what is termed the Robson massif may be gained. Directly opposite protrudes a great monument of solid barren rock called Iyatunga (black rock), and just back of this Robson towers, a veritable pinnacle of the world, its rocky cliffs 7,000 feet from the shores of Berg Lake rising to the summit where gather daily the mists and rain clouds from the Pacific to be condensed into snow and ice, thus adding constantly to the deep snow banks and wide ice-fields which form a perpetual crown for this regal peak, and make possible the several giant glaciers. Down its eroded sides sweep three of these rivers of solid ice. The largest and longest of them, Hunga, formerly Robson Glacier, but renamed from the Assiniboine Indian word for chief, is formed in the *névé* between Robson Peak and Mount Resplendent. From there it swerves to the northwest, encircling the base of the peak with its chill arm, and glides sedately between Iyatunga and Titkana (bird peak), not unlike a polar giant's stairway descending in a slow, graceful spiral through these two mountainous newell posts, a distance of over three miles, to where it breaks up in the pass below. Of the two other glaciers to the southeast, both of which slide more directly into the lake, the nearer one, Blue, is the more attractive feature, on account of its nearly head-long drop of over a mile from the icy crest of the Peak to the lake shore, where its great ice sheet, now fully two miles in width, is dismembered into small bergs which float away. Blue Glacier, literally a sparkling, frigid river of bluish ice, hangs, apparently suspended by some strange force, ready to fall *en masse*, at any moment from its precipitous bed. The other, Chupo (Mist) Glacier, scarcely visible in its envelope of clouds and mist, though not so remarkable for its beauty and size, proves of great geologic value; it bears on its surface and in its icy grasp many fossiliferous rocks dragged from the top of the mountain to the moraine below, which frequently contain interesting fossil specimens in the form of marine shells and fragments of crab-like animals of the so-called Ordovician time. Beyond the glaciers, far to the southeast, is the Miniohan mountain range, which lends perspective to the scene by forming a distant horizon, while on the northwest, Titkana, once known as Ptarmigan Peak, frames the picture with its high, rocky slopes.

Fig. 1.—A view of Robson Peak, the pinnacle of the Canadian Alps. Spring in the valley and winter on the mountain. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

Just three and one half miles north-northeast of Robson the Continental Divide runs from Yellowhead Pass irregularly to the northwest, passing between Lake Adolphus and Berg Lake. On a rocky projection near Titkana Peak, the water from the Hunga Glacier divides; one stream turns to the northwest to Lake Adolphus, into the Smoky River drainage of Alberta, thence through the Peace and Slave Rivers to Great Slave Lake, and north *via* the McKenzie River into the Arctic Ocean; the larger stream flows southwest into Berg Lake, from there over Emperor Falls into Grand Fork and Fraser Rivers, and eventually to the Pacific Ocean. It is possible to stand on a certain block of ice on the Hunga Glacier and watch the water running over its surface divide, on this very block, and flow, one branch to the Pacific and the other to the Arctic Ocean. One experiences an odd sensation, thus to stand, as it were, on the ridge pole of the continent, where the future course of a floating chip or other object may be determined by a slight movement of the observer's foot or hand, causing it to take either the right or left hand branch.

To this Canadian alpine district, Dr. Walcott makes summer trips for the continuance of his investigations and studies in the comparison of the section of Cambrian rocks there, with that of the line of the railway, one hundred and fifty miles to the south.

Outfitting at Fitzhugh, a small town on the Grand Trunk Pacific, last summer's party crossed the Continental Divide over the Yellowhead Pass and turned north from the railway at Moose River, seventeen miles west of the pass. From this point they followed the course of the Moose River to its source in the pass of that name, making several stops *en route*, and encamped at the head of Calumet Creek, a tributary of the Smoky River. The camp farthest out, the final one, was at Robson Pass between Berg Lake and Lake Adolphus, from which several side trips were made.

Besides carrying out the main object of the expedition, that of securing specimens of the various fossils from the localities visited, and making a general reconnaissance-section of the great block of Cambrian and Ordovician strata from which the mountains of this region have been formed by uplift and erosion, Dr. Walcott found opportunity for making many fine photographs, especially panoramic views showing the geological formations, while Mr. Lett photographed a number of unusually striking and picturesque scenes in this neighborhood. Through the courtesies of these gentlemen, several photographs are herewith reproduced.

The summer's observations and measurements extended the geological section from Moose Pass southwest over Tah Peak, Mount Mahto, Titkana Peak, and across, by way of Phillips Mountain and the ridges of the Lynx Mountains, including Billings Butte, to Robson Peak. By air line, the actual distance was only nine and one half miles, but the course followed was necessarily a very irregular one, since it was only possible to examine the exposed sections free from snow fields and glaciers, and consequently covered a great distance. It was found that the depth of the stratigraphic section examined was approximately 12,000 feet of Cambrian rocks and 3,000 feet of Ordovician; the transition between the two systems being in Billings Butte, which projects upward near Hunga Glacier.

Many fine specimens of a new sub-fauna of the Lower Cambrian series of rocks were located by Dr. Walcott at the northern base of Mumm Peak above Mural Glacier, which will add materially to the National Museum collections, already well advanced by his extensive contributions.

Undoubtedly the work of Dr. Walcott in this vicinity, and generally in the Canadian Rockies, has done more toward the advancement of human knowledge in invertebrate paleontology, especially as regards the Cambrian life, than that of any other student of similar researches. His prime object seems to be the true one of advancing the knowlege of geology and paleontology of this district, generally and not solely through his own researches. In this respect many of his photographs are taken with a view of enabling future explorers and scientists to recognize the localities and the general positions of the formations he has discovered. Further than this, he has revised, to a certain extent with the approval of the Canadian Board of Geographic Names, the nomenclature of many points of general and particular interest, making their locations and designations clearer by labeling his wonderfully detailed panoramic views, thereby happily tying art and science. In a recent Smithsonian publication he states with modesty, that although he was not the original explorer of this district, it fell to his lot to be the first to make a study of the geologic section, and this necessitated the application of additional names in locating, describing, and designating the geologic formations.

Two members of the party devoted their time to zoological collecting, and secured a number of mammal skins and skulls for the National Museum, thereby increasing the earlier collections obtained in this region by the Smithsonian Biological Survey party which accompanied the Alpine Club on the topographical survey in the summer of 1911.

With the completion of the railroads and the continuation of scientific researches, with the resulting literature of both, there is little doubt that the Robson Peak District will be well advertised, or that this high, cool, clear-aired portion of the country will remain long unknown and unvisited by the tourist, the vacationist, and eventually the home-seeker.

Fig. 13.—Robson, from a point on the south slope of Mumm Peak; Robson Peak to the right of the center; Hunga Glacier flowing into Robson Pass from between Titkana and Iytunga Mountains; Blue and Chupo Glaciers on the right, gliding directly into Berg Lake. Photo by Dr. Charles D. Walcott.

Fig. 2.—A misty day at Camp A, on Hihuna River above its junction with the Moose. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

Fig. 5.—On the slope of Mahto Mountain; Robson and Mumm Peaks in the distance. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

Fig. 8.—An unnamed glacier above Moose Pass and below Calumet Peak. The three men on the glacier give an idea as to its size and extent. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

Fig. 9.—Looking down through the Valley of Flowers, toward the first camp in Calumet Creek. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

Fig. 15.—Looking down into Calumet Creek; Tah Peak in the center above Moose Pass; to the right Lynx Mountain; Robson Peak, above Berg Lake; and Mumm Peak showing Mural Glacier. Photo by Dr. Charles D. Walcott.

THE PINNACLE OF

Fig. 14.—Looking south across the flats of Calumet Creek; Tah (Moose) Peak is in the center, with Moose Pass below at the left, and Mahto (Grizzly Bear) Mountain is seen on the right. Photo by Dr. Charles D. Walcott.

Fig. 6.—Dreamland, at the foot of Robson; Blue Glacier and Berg Lake. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

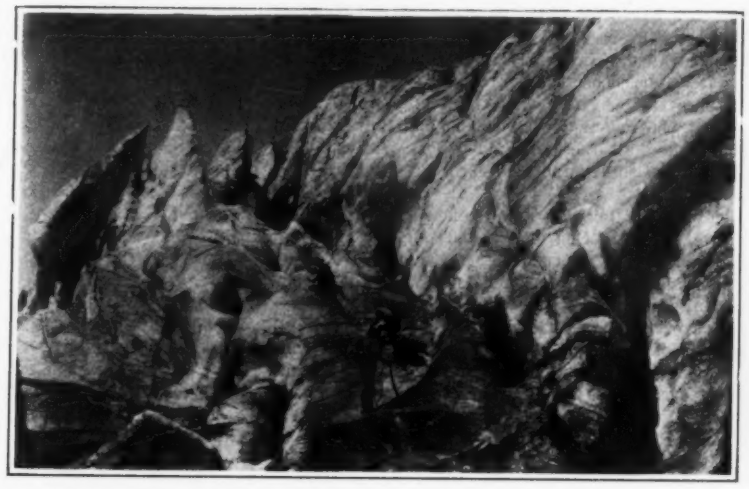


Fig. 7.—Climbing Alpine fashion over the ice-foot of the Hunga Glacier. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

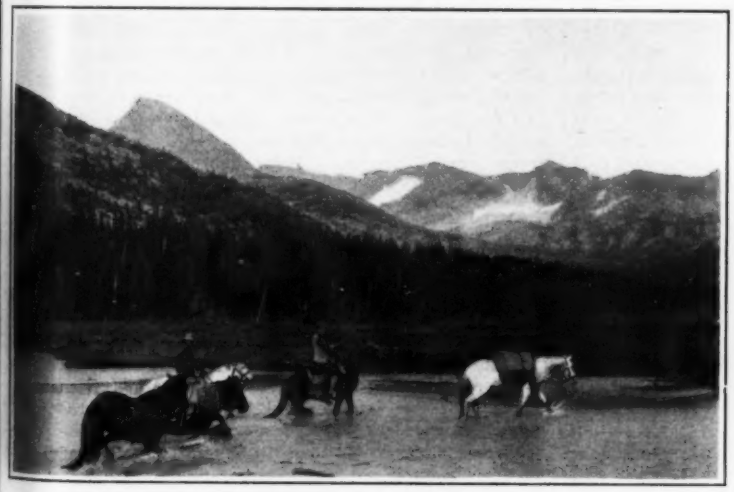


Fig. 12.—Dr. Walcott and party crossing Calumet Creek. Photo by Mr. R. C. W. Lett, Grand Trunk Pacific Railway.

Fig. 17.—Phillips Mountain with Cushina Glacier extending a mile down its west slope. Photo by Dr. Charles D. Walcott.

Fig. 16.—Calumet Creek from Camp A, above the junction of the Moose and Hihuna Rivers, nine miles southeast from Robson. The Lynx Mountains in the mist. Photo by Dr. Charles D. Walcott.

American Opportunity in a World Catastrophe*

Will We Profit by Past History?

By Harrington Emerson

Act, although unprepared! Act wisely! The national opportunity of a millennium is ours. Shall we of the United States be found as ready and as courageous as is Germany? Our courage, our wisdom, should be for peace, for advancement, not for destruction of civilization.

Great opportunities come as rarely in the life of nations as in the life of an individual. If the moment is missed it never returns. Such an opportunity came to Japan in the seventeenth century. Her junks were navigating everywhere in eastern Asiatic waters; they had crossed to the North American coast, and hers it was for the taking. Spain, Russia came a hundred years later, England the United States one hundred and fifty years later. Instead of seizing the new world to the east open to her, even as France, England, Spain, and Portugal seized the new world to the west, open to them, Japan destroyed her mercantile marine and deliberately turned her back on the sea.

France similarly did worse than miss world opportunity. She forfeited what she had already attained. Canada and all the Canadian Hinterland was hers, Louisiana and all its northwestern extension was hers. She let it go!

Spain at one time possessed the new world by right of discovery from Florida to Patagonia and she lost it all.

England by a little common sense might have guided for a while then have been federated with what is now the United States.

Each of these countries at the critical moment faltered and failed. Shall we of the United States, when our great opportunity comes, falter and fail, or shall we set a mark that it will keep us busy a hundred years to attain?

There are eight great powers in the world. In the order of their population they are found to rank as follows:

British Empire,
Chinese Republic,
Russian Empire,
Great American Republic, the United States,
French Republic,
German Empire,
Japanese Empire,
Austrian Empire.

To-day six of these great world powers are embroiled in war—three, aided by three or four smaller powers, against two; Slav, French, England, Portuguese, possibly Japanese and Italy, arrayed against the Teutons!

The Chinese Republic is torn by internal strife and for the moment does not count. The United States, owing to the peace and justice-loving efforts of a great President, is not embroiled in any war with Mexico. The United States stands alone—able, if we have the courage and ability, to push forward civilizing ideals and that financial and industrial supremacy to which each modern nation legitimately aspires, a supremacy that makes for leadership.

We are unprepared! As colonists and as a nation we have rejected all the traditions and fundamentals of great organizations and great policies. Those fundamentals are definite ideals, permanence of executive authority, persistence of policy, accumulation and utilization of past experiences, authority commensurate with responsibilities. The United States in its growth is not a creation; it just happened and is still happening; but the time has come to stop happening and to look ahead and act, not for the moment, but for all time.

The greatest of all wars that the world has ever seen has been brought about by ideals—ideals not of expansion through civilization, but of expansion through conquest.

Ever since the time of Peter the Great, ever since he wrested the shores of the Baltic from Charles of Sweden, the shores of the Black Sea from the Turks, ever since Bering dragged overland from Moscow the boat he launched in Pacific waters, Russia has aspired to an outlet on unfrozen seas. In land conquest and land absorption she has steadily realized her ideals. Russia, in land area, has grown more rapidly and more recently than our thirteen colonies; but toward the sea she has been thwarted. By combinations in Europe she was bottled in the brackish, shallow, frozen Baltic. England and France by war bottled her into the Black Sea, and European concerts have repeatedly since stopped her march on Constantinople. Towards the west (although Vladivostok is as far south as the semi-tropical southern coast of France, it is nevertheless frozen in through the winter), the Japanese wrested Port Arthur and Manchuria from her.

Kuropatkin, the great Russian general of the Russo-Japanese war, bitterly deplored this activity of Russia in the far east. "Our danger lies on our western border," he said. "We are playing into the hands of our enemies." And so it has proved.

Austria also, and behind Austria, Germany, are both determined to expand by conquest. These nations believe that trade follows the sword, and that race and nationality are more important than civilization. So Austria and Germany are determined to control the Balkan peninsula, to possess Constantinople, to occupy and develop Asia Minor and old Assyria and Babylonia.

England always had oversea land-hunger, and while the other nations were still asleep she appropriated almost half of North America, all of Australia, a large portion of Africa from Cairo to the Cape, the choicest part of southern Asia; and as part of her policy, starting with the north side of what she calls the English Channel, England also appropriated the strategic parts of the ocean, as Gibraltar, the Suez Canal, Aden, Cape Town, the Malacca Strait, the north of the St. Lawrence and the north shore of all the American Great Lakes, and the north shore of the Straits of Juan de Fuca.

England failed in her ideals when she drove the colonies into rebellion, and under Lord Palmerston she most surprisingly overlooked the opportunity to take over the whole of equatorial Africa and to annex southern Patagonia with the Straits of Magellan.

France, which let North America slip out of her grasp, has for centuries held to utopian ideals of glory and of balance of power in Europe. At this distance we cannot sympathize with the long wars of the Spanish succession, nor with France's wars with Russia, with Austria and with Germany under Louis Napoleon. They weakened France and they unified Germany.

Since the Burgrave of Nürnberg lent money to the Emperor Sigismund and took in pledge the borderland of Brandenburg, the wonderfully thrifty, ambitious, persistent, courageous, and industrious Hohenzollern rulers have aggrandized their dominion—from county into electorate, from electorate into kingdom, from kingdom into headship of North Germany, from headship of North Germany into imperial leadership of all Germany.

The Hohenzollerns have not overlooked any opportunity to advance the one ideal of dominating expansion, and they have persistently used all the fundamentals of organization. The warlike ideal, however, has been largely forced upon Prussia. Russia, Austria, and France all combined against Frederick the Great, and it was only by very great ability as General and King that he saved Prussia from the fate of Poland. Prussia was beaten to a finish and partly dismembered by Napoleon. In 1866 there was a German coalition against Prussia of nearly all the other German States, including the Austrian Empire. It was only by stupendous Bismarckian skill in diplomacy and von Moltkean skill in military organization and strategy (both being supported by the old King, wise in the tradition of his house) that Prussia emerged triumphant; and such a triumph!

On June 14th 1866, Bismarck laid before the German Diet, a Prussian plan for the settlement of the Holstein-Schleswig question, and threatened with loss of existence any small German State which should vote against Prussia. Nevertheless he was voted down, and *the next day*, June 15th, the Prussian armies invaded Saxony and Hanover. On July 3rd, the decisive battle of the war was fought; and peace soon followed, the terms being that Prussia got all it wanted. The coalition Prussia attacked had twice the land area and twice the inhabitants of Prussia, but it proved no match for Prussian skill.

Prussia never vacillated. In 1864 England and France vacillated as to the protection of Denmark, thus allowing Prussia to acquire Holstein, and later to build the Kiel Canal, which makes the Baltic a German harbor.

In 1866 France vacillated, was not ready, allowed herself to be cozened by veiled and non-specific promises of compensation. In 1870 France played into Bismarck's and Von Moltke's hands by losing her head over the Spanish throne incident. Germany was ready, and Bismarck knew it; France was not ready, and Bismarck knew that also. Austria expected to help France; but war was declared so suddenly, July 15th, 1870, the Germans mobilized so much faster than the French and were in French territory in three weeks, that the Austrians lapsed into quiescence. Germany was strong enough and ready to fight both France and Austria. I personally saw Germany go into that war.

I shall try to give Americans some idea of the German war game. Did you ever see an American circus mobilize, break camp, move and set up again? It is one of the most wonderful examples of efficiency we have produced. The great tent city is in full swing at 10 P. M. The next day at 10 A. M. it is parading the streets of a town a hundred miles away. The German army mobilizes and moves like an American circus in the height of the season.

Did you ever see a major league game of baseball played? There are the rules of the game, there is the coaching of the outs, there is the center fielder, for instance, who knows the rules, listens to the coach, but has his eyes, legs, and hands ready for any batted ball that comes his way. When he is running for a catch other things had better get out of his road. These are the German tactics—perfect organization, the rules understood by all, the team drilled to act as a unit, yet each unit able, competent, and instructed to act on his own initiative in his own region. But the German game is played with 2,000,000 players on a side.

Did you ever see an American fire department answer the gong and hurry to a big fire? They stop at nothing and for nothing. Everybody else gets out of their way. Trolley cars stop, horses and vehicles line up along the curb, pedestrians clear the streets. The fire department is rushing into war with fire, and well it knows the value of seconds and of hitting hard and strong. That is the way the German army goes into war, which suddenly becomes the one supreme business. Civil rights there are none any more. You sit up and take notice that war holds the center of ths stage as well as the wings.

Did you ever consider the wonder of the weather bureau service? Every morning your paper tells you what the weather will be for the day. The facts were gathered over the whole broad expanse of North America, were wired into Washington, there analyzed and interpreted, and the warnings sent out. It all has to be done in a few hours. By a system similar in its completeness the German general staff knows what is happening everywhere all the time. Before dawn the following day, Von Moltke knew more about the battle of Gravelotte—a widely extended battle, which continued until after dark—knew more of the position of the various troops and their condition and availability for further action, than we know now about the battle of Gettysburg.

Owing to the baseball organization of the Prussian army, owing to its circus-like mobilization and movement, owing to its fire-department suddenness and energy, owing to the perfection of its information, seven weeks after war was declared in 1870 the war was practically ended by the surrender of the French Emperor and his army and the bottling up of Bazaine and his army at Metz.

Out of the ashes of the war of 1870 the German Empire arose, North and South Germany united, and augmented by the annexation of Alsace-Lorraine; Russia and England held aloof, triumphant Germany was strong enough to oppose them both.

I do not like the Prussian ideal of conquest, annexation, as a means of extending German civilization. Belgium, Holland, Switzerland were prosperous, without lust for expansion, and the United States believes there is more for both countries in aiding Mexico than in conquering her. Nevertheless, holding as her chief ideal offensive wars of aggrandizement, the German army lives up to the ideal. It declares war with instant suddenness, it mobilizes almost over night, and it strikes first and hard.

Germany has this time only repeated on a larger scale what Prussia did in 1866, what the German Bund did in 1870. Holding to the ideal of expansion, Luxembourg, Belgium, Holland, Switzerland as possible prizes if they dared stand in the way, another slice of France, Russian Poland, perhaps Finland, the incorporation of German Austria and Hungary in the empire, unlimited expansion toward Constantinople, toward Bagdad and beyond—why not strike immediately before Russia and France and England became any stronger? If the Germans succeed there will still be a Russia, still be a France, still be a Great Britain, even as there was still an Austria after 1866, still a France after 1871.

* *The Engineering Magazine.*

If Germany fails there will still be a great Germany, pushed back perhaps to the Rhine, rectifying perhaps the Russian frontier, but with Oriental dreams shattered, and with the Slav holding the Balkans.

How long will the war last? David Starr Jordan is quoted as saying it will cost $50,000,000 a day; already $5,000,000,000 have been voted to be spent, in addition to the immense war chests and war supplies already on hand. The casualties to date show a loss of life exceeding 3,000 a day. The war is not likely to last over six months.

What is the outlook for America? For your neighbor's house to be on fire is never a good thing for you. On the contrary, we want our neighbors to be ten times as prosperous as they are so that we can sell more to them. Impoverished neighbors cannot buy our products, and that will affect all business adversely. Nevertheless the South African war stimulated the mule market in the United States, and wheat and corn have already risen in price.

While the great destruction is on, and when it is over, Europe will need our accumulations, and will not only pay an enhanced price for them, but will pay with our own best securities at greatly lowered prices. Thus doubly will Europe be made tributary to us. But it is never in the long run advantageous to take your neighbor's capital.

The war must be short, and marvelous is the recuperative power of combatants. Men of arm-bearing age are, as a rule, only 5 per cent efficient; the average is rather less than this compared to the best, 100 per cent, the picked few who are in all respects sound. A very little absolute improvement in efficiency might double the average. Other great wars have this effect on a people. They climb out of their ruts, they break away from tradition.

There was a great up-swing in the United States after 1865, in Germany after 1866, in France and Germany after 1871.

The destruction of war is not nearly as great as it seems. If people do not produce, neither do they consume, and the man who may have been making and spending $10 a day, comes down to the $1 or even to the $0.10 level without particular detriment either to himself or to his similarly placed neighbors. The total wealth of Germany is $60,500,000,000, and even if the actual war wastes were $2,000,000 a day, this in a whole year would amount to less than 1 per cent of its accumulated wealth.

The average death rate in Germany is probably 20 per thousand, or 1,200,000 a year. Kill a million soldiers and you have only doubled for one year the normal outflow. In four years, if the normal rate were lessened from 20 per cent to 15 per cent, the loss would be numerically made up. The loss of life, the loss of time, the loss of property in a six months' war is, after all, insignificant compared to the great enduring life of the nation. Recuperation will be rapid.

If business is not to be immediately boomed in the United States, if Europe is rapidly to recuperate whoever wins, what legitimate advantage is in store for us? The American ideal is not one of war, but of peace, and in so far as that ideal is better for humanity, it is well that American influence shall be extended through the world.

Are we unprepared? Have we no policy? Are we to drift? Is the stupendous opportunity to be forfeited?

Our currency bill has been passed, giving us almost unlimited ability to expand financially. South America has been financed by England and Germany. It is our opportunity to finance our American neighbors and to reap the reward of the patient policy as to Mexico. Are we wise enough to meet the expectation?

The Panama Canal is completed and the west coast of South America is at our doors, ready to extend us a hearty welcome.

The mercantile marine of the great powers is flocking to our flag, where it ought to stay. Are we wise enough to secure it, and to expand it?

The nations of the world are taking over the home supplies lest there be a shortage. Is our Government wise enough to see the need of taking over the cotton crop, the wheat crop, the corn crop, and a number of other staples, at a normally high price, holding them until the world needs them and must have them?

I believe that every individual should do all he can for himself up to the limit of his capacity. He should be a doer. Beyond that capacity begins the normal function and responsibility of the corporation. The State's duties begin where those of the corporation reach their limit. The southern farmer has raised all the cotton he knew how to, probably not more than half of what he ought to have raised per acre. Corporations have ginned it for him and compressed it and stand ready to haul it to market. No corporation can buy and hold the whole cotton crop or any part of it. It is the duty of the Government to place in reservoir the flood of the unmarketable cotton and to hold it at a minimum export price until wanted.

Here there are great national possibilities and policies for which we need the power of the Government:

First—To assure such currency facilities as will enable us to buy back our investment securities at the low price at which they are offered.

Second—So to assist our banks as to enable us to finance the world's colonial trade which the warring nations are dropping.

Third—To take over the mercantile marine of the world so as to carry our supplies to those who either now or later will so urgently need them.

Fourth—To take over and hold until needed the export staples of the country, especially those temporarily depressed. Shall our farmers sell cotton at half price now, when before the next crop is gathered it will command a war price?

Great lines of peaceful expansion and growth are, in this great catastrophe, ours for the taking. Never was there such an opportunity before, and let us hope that it will never come again.

We must act now, or forever regret.

Marine Birds and Hydro-Aeroplanes

THE Director of the Laboratory of Aviation in the French École des Hautes Études, Dr. Magnan, has made a minute study during the past five years of the characteristics of sea-birds, with the object of deducing principles therefrom which might aid in the perfecting of aeroplanes. He has rigorously calculated the wing-surface, the weight and width of the wings, their spread, and the total length of many hundreds of birds, taking careful note in each case of the mode of flight. He has observed that the various relative dimensions were practically constant for the species of the same group of birds practising the same sort of flight.

Thus, all the birds of prey flying by day have practically the same wing-surface, the relation of their wing-spread to the length of the body being constant. On the other hand, these dimensions differ considerably when different groups of birds are considered, as birds of prey, marine palmipeds, and birds of passage.

At a recent meeting of the French Académie des Sciences, an account of Dr. Magnan's researches was presented by M. Ed. Périer, who said:

"In investigating the characteristics of marine birds (palmipeds) he has been able to define them thus: The marine palmipeds possess the greatest relative wing-spread found among birds of any kind; on the other hand, they have the narrowest wings. Their wing-surface is very large, but less, however, than that of the predaceous birds. The tail is considerably abbreviated, but the total length is nearly the same as that of the birds of prey, in spite of this shortening of the tail. The relation of the wing-spread to the width of wing is greater.

"M. Magnan shows also that the narrowness of the wing and the shortening of the tail seem to be the result of an adaptation to flight in the great currents of air, since all the water birds (ducks, small wading birds) which fly in analogous conditions also have narrow wings and short tails.

"M. Magnan had already proved by his study of soaring birds that it was possible to make a practical application in aeroplanes of the dimensions discovered by him in birds. The Ponnier monoplane piloted by E. Védrines in the Gordon Bennett Cup Race of 1913, contained both the first application and the justification of his researches. The fuselage of this monoplane possesses characteristics which are absolutely individual; it presents, in accordance with the results of M. Magnan's observations, the lowest proportion of total length to wing-spread. This reduction of the fuselage permits very rapid leaving of the ground, and seems to give a superior ascensional speed, since, in the cavalry type of avion, Bielovucic has attained a height of 1,500 meters in 5 minutes.

"M. Magnan has calculated the dimensions of a monoplane modeled after marine birds, as well as those of the soaring machines, which copy the birds of prey. His figures, in a machine weighing 400 kilogrammes in flying order, are as follows:

"Wing-surface in soaring monoplane of the bird-of-prey type equals 12.60 square meters; and 10.20 square meters for the monoplane of the marine-bird type.

"Weight of wings, 78.800 kilogrammes and 77.800 kilogrammes, respectively.

"Wing-spread, 9.78 meters and 10.30 meters, respectively.

"Width of wing, 1.69 meters and 1.25 meters, respectively.

"Length of tail, 1.90 meters and 1.32 meters, respectively.

"Length of machine, 4.34 meters and 4.26 meters, respectively.

"It will be seen that there are very noteworthy differences between these two types. It may be that builders will be inspired to make use of these conclusions, either in total or in part, in the construction of hydro-aeroplanes."—*L'Aerophile.*

A Fossil Human Skeleton from German East Africa

By George G. MacCurdy

AT a meeting of the Gesellschaft Naturforschender Freunde, in Berlin, on March 17th, 1914, Dr. Hans Reck made a preliminary report on a discovery that is of special interest to anthropologists. Dr. Reck was attached to a geological expedition that had been sent out to survey a parallel running through the northern end of German East Africa, as well as to collect for the Geologic-Paleontologic Institute of the University of Berlin and the Paleontological Museum at Munich.

The discovery in question was made in Oldoway hollow or gorge on the eastern margin of the Serengeti steppe. The Oldoway gorge lays bare a series of tufaceous layers that had been deposited in a fresh water lake. Five deposits can be distinguished stratigraphically as well as paleontologically. In the lowest deposit fossil remains are rare, the chief specimen being a part of a rhinoceros skeleton. The second deposit is rich in fossil mammalian remains, including the human skeleton. Remains of two types of fossil elephant, both different from the living *Elephas africanus*, were especially abundant; the skull of a hippopotamus was also found in deposit number two. Bones of the antelope appear for the first time in the third deposit, which also contains bones of the elephant. Elephant remains are dominant in the fourth deposit; fish bones are also abundant. The fifth and latest of the deposits is the richest of all in fossils. It is characterized by an antelope and gazelle fauna similar to that now living on the Serengeti steppe. In this deposit Reck found no elephant remains.

The change in fauna represented by the series corresponds to a change in climate. The climate of the upper horizon was similar to that of to-day; while the elephant, rhinoceros, hippopotamus, crocodile, and fish of the lower horizons bespeak a damp woodland climate that was probably synchronous with the Würm glacial epoch in Europe.

The human skeleton, as has been said, came from the next to the lowest horizon (No. 2). It is not only in a good state of preservation, but is likewise practically complete. The skeleton was found some three or four meters below the rim of the Oldoway gorge, which here is about fifty meters deep. The skeleton bore the same relation to the stratified bed as did the other mammalian remains and was dug out of the hard clay tuff with hammer and chisel just as these were. In other words, the conditions of the find were such as to exclude the possibility of an interment. The human bones are therefore as old as the deposit (No. 2).

An attempt to determine the age of the human skeleton with any degree of accuracy must, of course, wait upon a further study of the geologic and paleontologic data, as well as on a more thorough-going somatologic study of the skeleton itself. Dr. Reck is, however, already convinced that it antedates the so-called alluvial or recent period. The thickness of the deposits indicates a considerable lapse of time, especially when one recalls that at least two of the superposed deposits were laid down before the faulting occurred, and with it the drying up of the lake. The change in fauna from rhinoceros, hippopotamus and two types of elephant both different from the living African elephant, to a gazelle and antelope fauna is likewise proof of considerable antiquity. Judging from the photograph of the skeleton still *in situ*, the man of Oldoway gorge did not belong to the Neandertal, but rather to the Aurignacian type of man. In the absence, however, of industrial remains and even photographs in detail, any pronouncement as to racial affinities with known European Quaternary human remains would be merely a guess.—*Science.*

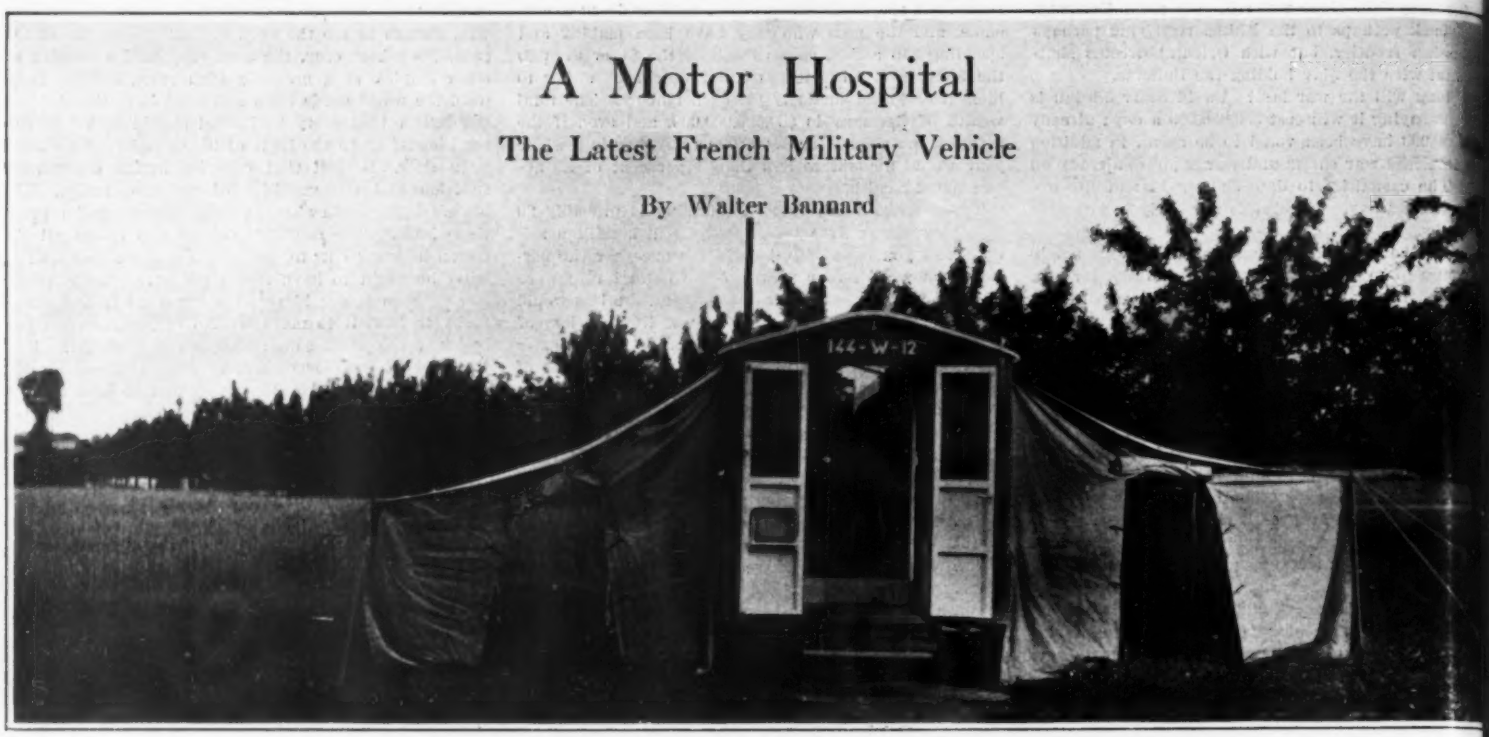
Activity of Freshly Formed Radium Emanation

H. H. POOLE, in the *Phil. Mag.*, says that as there is no very satisfactory explanation of the exponential law of radio-active decay, it is not unreasonable to suppose that variations from it might occur under certain conditions. For instance, as has been suggested by Joly, it is possible that the rate of decay, and hence the activity of a body, might be anomalous when the body is freshly formed, so that its age is only a very small fraction of its average life. Accordingly, the author has compared the activity of RaEm a few seconds old with that of the same emanation at the age of a few minutes. The results were negative, nothing anomalous being detected.

A Motor Hospital

The Latest French Military Vehicle

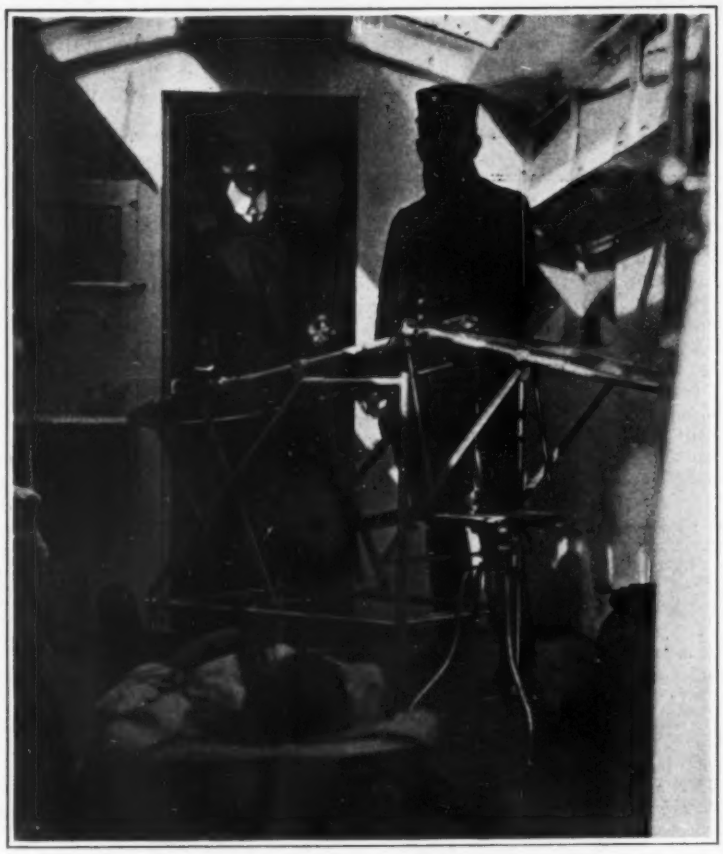
By Walter Bannard



THE French army has an automobile operating room, in which surgical operations can be performed at the battle-front in conditions as favorable as those afforded by a hospital. Severe abdominal wounds, which are very common in modern warfare, cannot be operated upon properly by the ordinary field service, and in many cases the removal of the patient is equivalent to a sentence of death.

The new vehicle, which has a 40 horse-power motor, capable of developing an average speed of 20 miles per hour, is furnished with all of the accessories and the latent improvements of a hospital operating room. Its principal compartment, the operating room proper, contains an improved operating table and a wash basin supplied with sterilized water. In front is a smaller compartment, containing the sterilizing apparatus and the electrical apparatus, which is operated by the motor, whether the vehicle is in motion or at rest.

A very ingenious arrangement enables the surgeon to locate the bullet accurately by the application of Roentgen rays. The operator, shielded from diffuse light by a photographer's hood, moves the fluorescent screen over the patient's body until the shadow of the bullet falls on a small hole at the center of the screen. By inserting a pencil in this hole, the position of the shadow is marked on a sheet of translucent paper, ruled in squares, which is placed under the screen. The angle of observation is then altered slightly and the new position of the projection of the bullet is marked in the same way on the ruled paper. From the distance between the two marks, the depth of the bullet can be obtained, by referring to a table computed in advance.



The operating room of the motor hospital contains operating table, trepanning apparatus, and sterilizing basin.

The operating room also contains a complete trepanning apparatus, which is operated by a special motor.

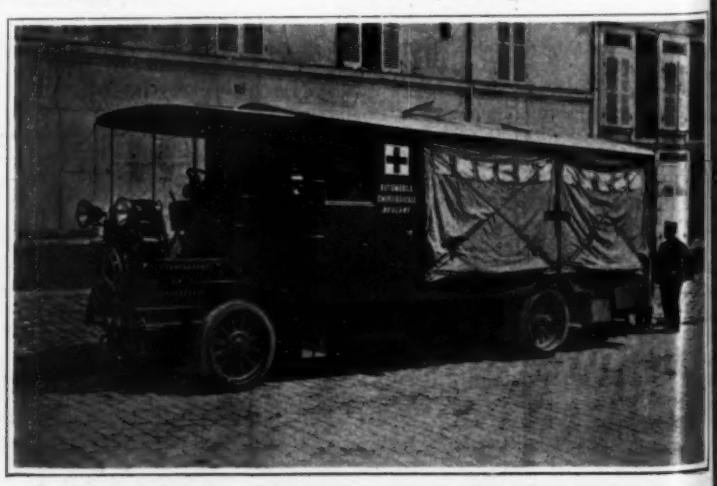
The vehicle carries an apparatus for sterilizing water by ultra-violet rays, for the use of the troops. The water is drawn from any convenient brook or pond by an electric pump.

A folding tent, for the shelter of patients before and after operation, is attached to each side of the vehicle.

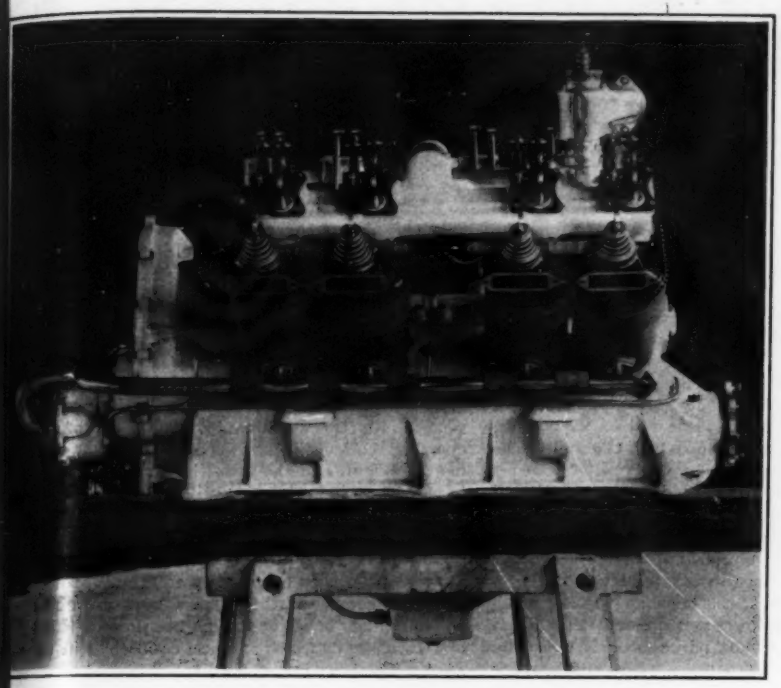
The employment of automobile operating rooms of this sort will save many lives. In the recent war in Manchuria the mortality among the severely wounded was 90 per cent, because of the inadequate facilities for prompt operatory treatment. This mortality can probably be diminished by two thirds by the use of automobile operating rooms in which operations can be performed in perfectly aseptic conditions, without loss of time, before the removal of the patient from the field.

A Number of Folding Go-cart Patents.—We are all more or less familiar with the general appearance of the folding go-carts or perambulators made partly of what appears to be oil cloth. Patents Nos. 1,094,417 to 1,094,419 on applications of Frank J. Beier, and Nos. 1,094,453 to 1,094,460, inclusive, on the applications of Albert E. McGill, have been granted showing various constructions of folding carts of this class. All of these patents except 1,094,457 have been issued to William S. Ferris, Elkhart, Ind., and Alexander B. Heith of Chicago, Ill., trustees, as assignees.

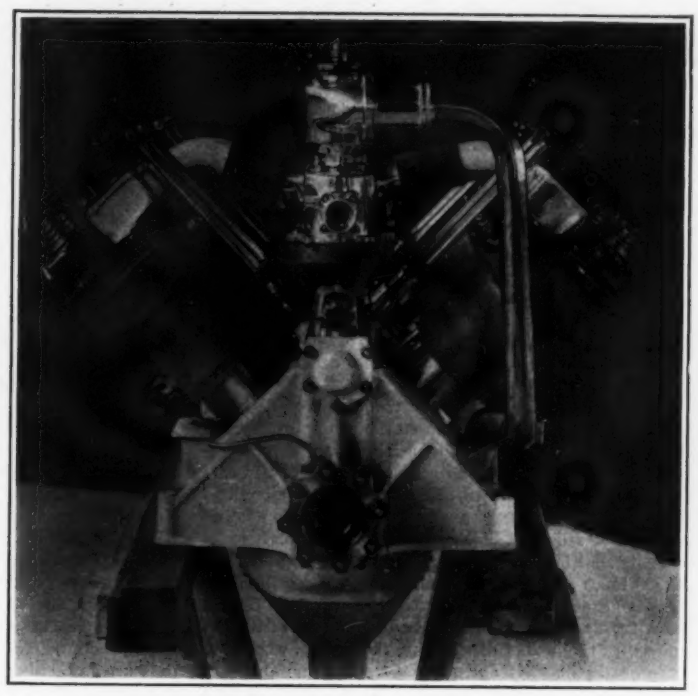
Showing the method of suspending stretchers in a military hospital vehicle, and the positions of the patients.



The motor hospital, besides its operating and sterilizing equipment, carries a shelter tent on each side, ready for pitching.



Side view of V type, water-cooled motor.



End view of V type motor, now favored for high powers.

Late Types of Aero Engines

With the natural advance in the art of aerial flight larger airships and planes of various kinds are constantly being designed, and for their operation there is a steadily increasing demand for more power; and indeed these demands for increased power have become so insistent that the designers and builders of engines of this class are finding it extremely difficult to keep up with them because of the limitations of weight and restrictions as to size. As a matter of fact the newer and larger of the flyers appear to depend more on increased power for their success than on any radical improvement in their conception; and while the restrictions imposed on the designers of the engines are within reasonable limits, a stimulus to improvement, the limitations to weight still insisted upon is producing an engine, which while remarkable for its mechanical perfection and efficiency, cannot be regarded in any sense as reliable, nor of a character that would be accepted for anything except purely experimental work.

Up to about one hundred horse-power the rotary type of motor gave very good results and was very favorably regarded, but where greater powers are required, and longer flights are contemplated, engines more nearly approaching automobile lines are preferred as they have proved themselves more dependable and durable, and many of the more recent flights that have been notable for either duration or distance have been made with the assistance of water-cooled motors of the above type.

Many of these new engines of high power that have been installed in foreign countries of late have been produced by well-known automobile builders, who have also had considerable experience with fast motorboats, and the aero engines they build may be considered a condensation of their experience with light, high-speed motors. One of the most recent designs is by the Wolseley Company, the well-known British builders, and as it is fairly typical of its class the accompanying illustrations and details are given.

This engine is a four-cycle of the "V" type having eight cylinders 5 by 7 bore and stroke set at an angle of 90 degrees on a cast aluminium crankcase. These cylinders are of high carbon steel, machined out of the solid and fitted with copper water-jackets. The pistons are of the same construction as the cylinders, and are fitted with four rings each, two of which are compression rings, while the other two merely serve as guides or bearings. The valves are placed in the cylinder head, and operated by overhead rocking levers and rods from an inclosed central camshaft that serves both sets of cylinders, and is driven from the crankshaft by gears. The valves are all set in removable seats, and the exhaust valves work in detachable water-cooled boxes. A forced system of lubrication is employed, one gear pump feeding oil under pressure to all important bearings, and a second pump returning the oil from the crankchamber base to the tank, the consumption being approximately 0.05 pint per brake horse-power hour. A gear pump working in conjunction with a radiator takes care of the cooling, while the ignition is the dual system, consisting of a high-tension magneto and coil, with starting switch and accumulator.

This engine weighs about 950 pounds, while the water in jackets and radiator amounts to 120 pounds. At 1,250 revolutions per minute 130 horse-power is developed with a consumption of approximately 0.65 pint of gasoline per brake horse-power hour. Any suitable carbureter may be used, and it can be placed as shown in the cuts, or located lower down at the end of the engine; while the gasoline can be fed by pressure if desired.

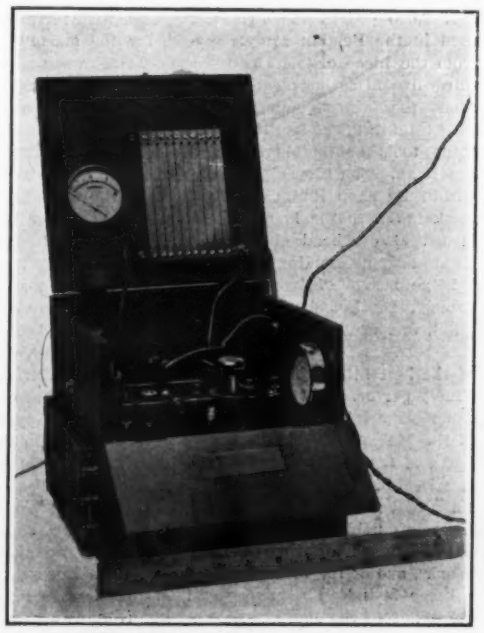
Wireless Communication and Aeronautics*

Facts Relating to Light Portable Apparatus

For wireless installations on board aeroplanes and balloons the most important consideration has been to install apparatus which will conform to the limitations of weight and space, and still provide a suitable and efficient means of transmitting messages to the desired points with the small aerial wire system and power of aircraft. The demand for light and portable stations for army and navy work is constantly increasing. In time of war, wireless communication is of great service in connection with aeronautics, for it enables the leaders to send commands rapidly and to learn the position of the enemy. The operator is usually carried as a passenger and transmits signals at the same time as he makes observations. The apparatus used is, in all respects, interchangeable with the portable field sets, as this enables any operator of the field signal corps to work the aeroplane outfit when necessary. It is so arranged that the machines are of the double key type, so that messages can be sent by either the aviator or the passenger.

The current is obtained from a generator, friction-driven from the fly-wheel of the engine or from storage cells. Experiments have also been made with wind motors where the generator was driven by an aeroplane. The equipment at present used by this government has an output of about 125 watts, weighs about 75 pounds, and, it is claimed, has a radius of 30 miles. A new equipment designed by the author has a total weight of less than 20 pounds with double the capacity and less than one half the space required by other outfits.

Recently several European Governments have been making experiments with apparatus for army work and have arranged conditions different from those which have been planned and adopted by all wireless workers up to date, in fact, have gone back to the old days when the ordinary Hertz oscillator, untuned and of open circuit, was used. Now several officials are suggesting the use of apparatus wherein the transmitter is not tuned, and they advance several points in its favor.



The Dubilier Wireless Apparatus.

First, in transmitting a sharply tuned signal it takes a longer time for the receptor to get into proper adjustment for receiving signals.

Secondly, the transmitter can be more quickly adjusted, as it is not necessary to adjust the oscillating circuits carefully in order to bring them in resonance.

Thirdly, messages can be sent in secret code. Hence it does not matter whether the enemy receives them or not. If the signals sent out are not tuned sharply, the greatest hindrance can be offered to the enemy by interfering with his stations; for it will be difficult for him to tune out these highly damped waves. It has therefore been desirable to send out waves with a flat resonance curve.

In order to get the largest amount of power out of the transmitting station and to arrange the circuits in resonance, the following figures will be of great interest to give one an idea of the size of the aerial and capacities required in installations:

The speed of electric waves is about one billion feet per second. If oscillations or waves of a frequency of one million is desired, it will be necessary to have a wave length of about one thousand feet; for to send messages with wave length of very much less is not practical, because

* Abstract from a paper by William Dubilier read before the Aeronautical Society of America, June 11th, where he prefaced his remarks with a note on the history of wireless and its adaptation to Aeronautics.

of many difficulties such as absorption, heat losses, induction losses, etc. Therefore, if signals are to be sent, longer wave length should be obtained by using large inductances. The size of these is also limited; for the machine again becomes inefficient when too much inductance and too little aerial capacity is used. Hence, a compromise must be made whereby sufficient aerial length and surface are coupled with a fairly large inductance. To get an idea of the length of the aerial roughly, the wave length transmitted is 5 times the length of the aerial wire system plus 10 times the length of wire in the coil or helix. To make up the length, usually a trailing wire is used which is led down from the aeroplane or balloon, or an auxiliary balloon is used for elevating wires. This plays a very important part in determining the range of a wireless station, for roughly it varies directly with the height of an aerial and cube root of the power.

Many different kinds of apparatus have been designed for aeroplane work. Portable stations supplied by the Marconi Company, type L, especially adapted for aeroplanes, weigh 50 pounds and have a capacity of 50 watts and a radius of about 10 miles. Type L1 weighs 200 pounds, has a capacity of about 500 watts, and a sending radius of 50 miles, while type M, for durable work, has a capacity of 1,500 watts, a sending radius from balloons of 200 miles and weighs 500 pounds. One of these installations, tried on board the "Flanders," British machine, and made up in two separate contained units with the idea of distributing the weight, was fitted underneath the pilot and passenger seat, and the only part exposed was the manipulating key with several controller switches which were placed in the most convenient position for the operator to carry out the simultaneous work of observing and reporting.

Another aeroplane installation used is one constructed by the Lorenz Company, using a quenched discharge gap for the production of nearly continuous oscillations. The weight of the transmitter without the generator is 100 pounds, the dynamo used is 500 volts, with a capacity of 500 watts. This apparatus consists of a discharge gap of two large electrodes, each electrode shaped like a half ball and cooled by a hydrocarbon vapor. Although this apparatus is not efficient, it has already been installed by several of the foreign governments.

The Telefunken Company have also made an apparatus for aeroplane work which has a capacity of about 300 watts, and occupies three cubic feet. A small dynamo is used, belt or friction driven from the main engine, and this apparatus has a sending radius of from fifteen to twenty miles.

For balloon installations, where large aerials can be constructed, much greater distances could be obtained. It has been reported that the Zeppelin airships are transmitting signals 200 miles with a 5 kilowatt installation, and all the Zeppelin airships that are making public trips have on board regular telegraph forms, the same as used on ship stations, so that passengers can send their messages at published rates to any part of the world. The aerial on board a Zeppelin dirigible is almost 600 feet long, and a 500-cycle generator is driven by an independent engine at a speed of 3,000 revolutions per minute. The wave length varies from 400 to 1,200 meters.

The greatest danger attached to balloons from wireless installations is the fact that the gas may become ignited by sparks produced by induced currents. This danger cannot be eliminated with the larger installations where high voltage transformers are used, but there are certain systems, such as the Poulsen, Lorenz and the author's, where the voltage of the transmitting oscillations is greatly reduced, thus eliminating to some extent the danger of induced currents. All metal parts such as valves, etc., must be thoroughly covered with a thick coating of some form of insulating varnish. For balloon work the wireless telephone is the most practical method for transmitting communications, for it eliminates the telegraph operator and the dangers of an explosion by brush discharge, and makes possible quick transmission of signals.

The portable Dubilier apparatus weighs 20 pounds, with a maximum capacity of one half kilowatt. The system eliminates the use of the difficult high frequency alternator. A small direct current dynamo is used, and then by a simple device alternating currents are produced having any desired frequency from 200 to 800 cycles, thus sending signals with musical notes. The apparatus is much easier and cheaper to construct than any yet provided for portable work; it is much smaller and much more compact for given power and is more portable and readily adopted for transport purposes; it is especially designed for aeroplane installations, where power, space and weight are important considerations.

From tests made by both the British and United States governments, the apparatus has proven itself more than twice as efficient as any of the machines yet tried. In a report issued by Capt. LeFroy, it is stated that with a 60-watt, 110-volt set, signals were sent from standard portable aerial and received on a service pack aerial 30 feet high consisting of 2 wires in parallel, 4 feet apart. A ground net with a peg driven 12 inches into the earth was used as a balance capacity. The station was erected on grass, and 104 volts direct current were used for transmitting. The current in the aerial was 1½ amperes. The condenser capacity was 0.0015 microfarads, a loose coupler being used. The maximum voltage across the spark gap was 7,000, which was of the quenched type adjusted to give the best readings in the aerial. Tests were made with three ranges in connection with a 300-watt Marconi installation set up alongside for comparisons. From Aldershot a motor car with a portable installation went out to three distances, first to Hook Common, 9 miles; second to Overton, 20 miles; third to Whitchurch, 25 miles. In the first two places signals were received clear, indeed with eight times the audibility at the latter test. At the third test the receiving end was connected to the wrong side of the aerial which was direct and which was in a valley so that no signals were obtained. Capt. LeFroy reported that this apparatus which weighed but 15 pounds, less the generator, had a safe range of 20 miles over land. The same apparatus operated on a 50-volt accumulator weighing 35 pounds had a clear radius of approximately the same distance.

Roughly the principle used is the producing of pulsating currents of a musical frequency from direct currents by means of a tuned circuit. This circuit contains a condenser charging device, a condenser and an inductance. The condenser charging device is set in operation mechanically or electromechanically, and, by means of springs, is given a certain definite working frequency, say 500 cycles. Then the inductance and capacity are so varied that the natural frequency is also 500 or a harmonic of the frequency of the oscillator. The primary current is transformed into pulsating currents having a sine wave with over 95 per cent efficiency. A suitable analogy can be shown by having constant water flowing out of a faucet which will represent direct current and then having another faucet with water running out into a cup or into a vessel which operates a lever by means of its weight when it becomes filled. This lever closes a valve and at the same time drops and turns over the vessel which releases the water. The release of the water operates the lever in the opposite direction, due to its lighter weight, and the vessel is then brought up again in position. The valve is simultaneously opened and the water again allowed to flow into the vessel until it is filled and then the operation is repeated. We have quantities of water thrown out instead of a continuous flow. Similarly this system operates on direct current.

The inductance of the primary oscillating circuit acts as the primary of a high tension transformer, the secondary discharge of which produces oscillations in the well-known manner. A quenched spark is used of a special design and is mounted inside the cover of the apparatus. This gap consists of long copper bars with smoothly planed ends placed about 0.003 of an inch apart, the discharge taking place between the planed ends. Any number can be connected by a small short-circuiting rod. The inductance is mounted in back of the instrument, and is connected to a hot wire ammeter which indicates the amount of power that is being radiated.

In experiments carried out by Messrs. E. J. Simon and L. J. Lesh, an aerofan was used to drive the generator. This was equipped on board a Curtiss military hydroaeroplane and was of about ¼ kilowatt capacity with a 500-cycle generator driven by a fan 20 inches in diameter. An aerial wire 600 feet long was wound on a reel, and weighted by a three pound piece of lead. This was used as the trailer and taken in as it became necessary. The installation weighed 105 pounds. It was found necessary to attain a fairly good speed to generate enough power to operate the apparatus efficiently.

The question of receiving signals on board aeroplanes and balloons has been a very difficult one, for the noise and vibrations of the engines and air currents make it impractical to receive signals with a telephone receiver. A receiving apparatus was designed for the Austrian Government in which a visible signal was used. The operator is able to observe dots and dashes by means of a small light. It is advisable to use Prof. Fleming's oscillation valve, or Dr. De Forest's audion, for they act as amplifiers to the received signals and are not affected by vibrations.

European Field Artillery*

A Discussion of Belgian, German, and French Guns

THE determined defense of the Belgians at Liege was made doubly necessary by reason of the important artillery and small-arms works located there. The Belgian government is almost wholly dependent on the Liege district for arms and armament.

IMPORTANT LIEGE INDUSTRIES.

The great Cockerill Works (Societe John Cockerill) is located close to Liege at the suburban town of Seraing. Ordinarily the Cockerill Works gives employment to more than 10,000 men. The principal output consists of artillery and coast defense material. Belgium for a number of years past has added armored cupola defenses to her land fortifications, and the majority of these cupolas were built by Cockerill. The standard Belgian field-artillery gun is of Cockerill design and is known as the Cockerill gun. The caliber is 2.95 inches. In addition to field-pieces Cockerill turns out large caliber guns for coast defense positions. The output at the Cockerill Works also includes locomotives, steam and gas engines, and a varied lot of railroad equipment. The plant is easily the most important in size and output in Belgium. Much of the machine-tool installation is not as modern as can be found in other Belgian plants, but of late years Cockerill has undertaken to introduce many American machine tools, and especially those of the automatic type, together with grinders and milling machines.

The Fabrique Nationale d'Armes de Guerre is located at Herstal, a suburb of Liege, and gives employment to over 3,000 people. The rifles, carbines, and revolvers used in the Belgian army emanate for the most part from the Liege district. In and about Liege are some thirty-five firms engaged in the production of sporting arms, the largest being probably the Pieper Works. This establishment has installed the latest types of machine tools obtainable and the equipment is largely American. The Pieper plant undertakes to do all work within its shop limits. Other shops arrange to have work taken to the homes of the workmen, under the idea that overhead charges are cut down. At such plants only assembling work is carried on.

Liege boasts of two important machine-tool works, namely, De Longdoz and Fetue-Defize. Still another plant, Jaspers, but smaller, is located there, and midway between Liege and Seraing is Req de Malzine, one of the best fitted up gear-cutting plants in all Europe. Ninety per cent of the machine tools at Malzine are of American origin. The same statement may almost apply to the Melnotte Works, located a short distance to the north of Liege. At the last named plant almost the entire installation of tools came from the United States. The great machinery works known as the Meuse Works lies just outside the city of Liege, while within the confines of the town proper is the St. Leonard Locomotive Works, one of the oldest and best known in Europe.

Liege is indeed a great machinery section, and the closing of all the above plants may naturally be expected in consequence of the war—all but the gun plants, since the latter can be utilized so long as they can be held.

BELGIAN AND FRENCH FIELD ARTILLERY.

The greatest importance is ascribed by military men to the part which field artillery will play in the present struggle. In 1870 France was clearly outclassed by Krupp wedge-block field guns. The French pinned great hopes on the mitrailleuse, a form of machine gun, but that weapon failed miserably at the very outset of the war. Private firms in Europe like Krupp, Skoda, Schneider & Co., and Cockerill have carried forward the development of field artillery year by year. Some idea of the advances made was first gleaned by the work of French guns in the Boer war. These pieces easily out-ranged the English standard field-pieces. The French guns in the hands of the Boers were Schneider pieces manufactured at Creusot, France. In the late Balkan war the Servians did remarkable work with still later makes of Schneider guns.

There is a popular impression that the French army is equipped with field guns of the type made familiar by the Servians and the Boers. This is erroneous. The French government gun is manufactured at the government arsenals and under no circumstances can it be purchased. The greatest secrecy surrounds the manufacture of this weapon, and it is the rule to keep the guns well covered with tarpaulins when on parade. French ordnance officers superintend all steps of the

* *The Iron Age.*

manufacture of these pieces, and there is no letting out or contracting on the part of private plants.

The field guns in use throughout the European services to-day all employ the long recoil system; that is to say, the gun carriage is immovable. In the case of guns not so equipped there is necessary a running of the gun into battery again after each discharge. The long recoil guns have the recoil taken up in cylinders either placed under the carriage or along the trail. The mechanical arrangement differs in different services, but the principle is the same, namely, to hold the gun carriage rigidly in place, and to allow the gun to recoil on the carriage, without moving the carriage. The energy of recoil is utilized to run the gun out after each discharge to its normal position on the carriage.

The effective development of the long recoil field carriage only began after 1897, when France had adopted her model of that year. When long recoil was first attempted, hydraulic transmission was tried, but the complications proved to be too great, and recourse was had to spiral springs. These springs were applied in the recoil cylinder in layers, with telescopic tubes. Ehrhardt, a German artillery manufacturer, tried to do without the tubes by winding the springs in the opposite direction, but this system has not been followed to any great extent. England purchased Ehrhardt guns during the Boer war, as her own pieces were recognized as having been outclassed.

In the late Krupp guns the action of the recoil is transmitted directly on a single spring without any of the complications arising through affording transmission between recoil and counter recoil. The brake piston rod of the Krupp field gun is held in the head of the cradle by a nut, and the brake cylinder is fixed to a lug at the breech of the gun. The spiral spring of flattened wire surrounding the cylinder is retained by the bottom of the cradle in the rear and compressed by a collar on the brake cylinder in front. The recoiling gun, pulling the cylinder back through the rear plate of the cradle, compresses the spring. There is no transmission, and recoil and compression are of equal length.

SHRAPNEL FIRE.

The object to be attained by modern field artillery is effective shrapnel fire. The majority of the European field pieces have a caliber of 2.95 inches and throw a shrapnel projectile weighing about 14½ pounds. This shrapnel shell is fitted with about 260 bullets, and experience shows that those bullets, to do effective work against men and horses, must have a striking energy of about 700 foot-pounds. The walls of the shrapnel shells are thin. Only a small bursting charge is necessary to tear open the walls and release the bullets. The bullets do not gain an increased impetus or velocity in consequence of this bursting of the shell; on the contrary, the velocity of the bullets following the burst is the velocity of the shell proper.

Shrapnel is burst over and short of the object fired at, and is designed especially for use against troops in the open or sheltered behind light screens. By being burst over earthworks, the bullets will search out the troops sheltered behind. The Boers found the English shrapnel so searching that they had recourse to digging their trenches at a slope, the bottom of the trench sloping toward the enemy.

The question as to the range of shrapnel depends on the initial velocity of the projectile. There is a maximum velocity dependent upon the firing charges of the gun itself. It is understood, however, that the new French guns have an effective shrapnel range of 6,000 yards. It was not many years ago when 3,500 yards was considered a good shrapnel range.

The effective use of shrapnel as in evidence to-day was unknown in the United States during the civil war. Solid shot and shells carrying lighted fuses were used for long-range work, and grape and canister for close work. The cannoneers stood up in the open. The caissons stood about fifteen to twenty yards in the rear, and men ran with the charges between the caissons and the guns.

MODERN PROTECTION TO GUNNERS.

All this is changed to-day. Instead of the caissons being in the rear, the French and Belgians place the gun caissons alongside the guns, and not more than two to three feet away. The guns are provided with shields, and after the first shot the gun is rigidly planted in the ground. Two men operate the piece, one to train and fire, and a second to load and eject the empty cartridge case.

The gun caisson or limber is up-ended much like a dump cart, only the ending of the caisson body is made complete; that is to say, it stands almost perpendicular to the ground and not at a slant. The projectiles when carried on the march have their heads down, but with the running of the caisson into battery and up-ending the cartridges lie parallel to the ground. The top of the caisson consists of two doors, which swing outward when the caisson is up-ended and form wind protections for the gunners who serve out the ammunition.

The bottom of the caisson and the wing doors are of light steel construction, not over ¼ inch in thickness, and are impervious to steel-jacketed bullets of the standard military rifle.

Three gunners kneel behind the protecting bottom of the caisson. They are completely sheltered from rifle fire. Two of these men pass out the ammunition; the third cuts the shrapnel fuse to the required number of seconds. As a rule the time of flight does not extend beyond 22 seconds, and for ordinary shrapnel service 10 to 12 seconds are employed. It all depends on the distance of the enemy. Good practice demands that the shrapnel be burst at a point about 150 yards short of the object fired at. The effect is to release the small balls within. The bullets then rush on at the full remaining velocity of the shell in the form of a sheaf, and strike the ground within a rectangle about the size of an ordinary company formation. The dispersion of the bullets is regulated largely by the position of the bursting-powder charge. In the case of some makes of shrapnel, the bursting charge is in the head of the projectile, while in other designs the charge is at the base of the shell. Shrapnel shells are in a number of services provided with percussion fuses in addition to the time mechanism. This insures the bursting of the shell when striking the ground.

RAPIDITY OF GUN SERVICE.

In the Belgian and French plan of placing the caissons when in action alongside of the guns there is gained great rapidity of service, and a rate of fourteen to fifteen aimed shots per minute is readily obtainable. An even higher rate of fire can be conducted, but fourteen aimed shots are perfectly practicable under varying conditions. By keeping the caisson close up to the guns there is avoided any exposure of men in running with ammunition to the guns. Opponents of the practice point out that if the caisson is exploded by a shot from the enemy it will probably also destroy the gun, but there is no knowledge, so far as known from experience, that the same thing would not happen if the caisson were exploded fifteen yards in the rear of the piece. The target presented by caisson and gun on the same front line is regarded as hardly more dangerous than a deep target afforded by placing the caisson fifteen yards to the rear. Incidentally, it may be remarked that the latter practice has been followed in the United States service, but many artillery officers believe that the Belgian and French method is preferable. In the French and Belgian practice the horses are moved off to the rear two hundred or three hundred yards, if necessary, wherever protection can be found in some hollow of the ground. Both the Belgians and French resort to indirect fire; that is to say, guns are sheltered behind a knoll or ridge, or, if necessary, sunk in pits, and the fire is directed by the battery commander from wherever he can best see. It is not necessary that the gunners have more than the range, time of flight, and direction of fire. The battery commander watches the burst of the shrapnel. If it is too short, he forks the object fired at by an increased range, and then reaches the object on the third shot by taking a mean of the two ranges. Seldom more than two trial shots are required.

The Krupp guns train through 8 degrees of arc without any necessity for shifting the carriage. French guns have greatly increased this train by having recourse to two additional trail flasks which are spread out V-fashion in rear of the gun.

FRENCH LONG RANGE GUNS.

It was Gen. Langlois of the French army who is regarded as the father of the present-day French army field-practice. This officer for several years urged upon the French government the developing of a gun which should be superior in range and rapidity of fire to any field gun in the world. His arguments and claims that the thing could be done finally resulted in the War Ministry taking the matter up in earnest. Langlois, as a practical artillerist, indicated what was required, and what should be striven for, and Col. Dupont, a renowned ordnance engineer, was assigned to work in conjunction with him. These two officers have evolved the field-piece which France now possesses and on which France depends for her armies to win in the field. The great Puteaux arsenal is responsible for many of these guns, and it may interest American machine-tool builders to know that American arsenal tools constitute the bulk of the equipment utilized in the fabrication of these pieces.

Lord Roberts is quoted as saying that the Boer war taught the necessity of having long-range guns with armies in the field. This necessity was felt when opposed to the Schneider guns of the Boers, the lighter guns having been outclassed. It will be recalled that the English sent to the front 4.7-inch and 6-inch naval guns taken from British cruisers and improvised carriages for the use of those guns on land. It is doubtful if any such disparity will arise between field guns in the various European services, but it is apparent that Krupp 75-millimeter (2.95-inch) field guns are unequal to attacking armored cupolas such as are found in the defenses of Liege. Against such defenses heavy pieces are needed, and then recourse must be had to specially built armored flat cars running on railroad tracks and of sufficient strength to withstand the heavy shock recoils. Such carriages, it is understood, exist, but the difficulty is to transport these armored trucks to the front, especially when railroads have been torn up, bridges destroyed, and roads damaged so as to prevent any rapid reconstruction. Against armored cupolas of the Belgian Cockerill type 8-inch guns, it is estimated, alone will suffice, and these 8-inch guns approximate fifteen and twenty tons in weight.

The Problem of Relativity*

THERE are two theories of relativity which should be clearly distinguished from each other. One, which may be called the theory of relativity in the strict sense, is supported by many observed facts, and is regarded by most physicists as the simplest theoretical expression of those facts. The other theory, which may be called the theory of relativity in the wider sense, has little, if any, experimental foundation, and is regarded with skepticism by the great majority of physicists.

I. THE THEORY OF RELATIVITY IN THE STRICT SENSE.

Newton's laws of motion do not hold for a system of co-ordinates moving in any manner whatever. But, if the motion is referred to a system for which these laws are true, they will be equally true for any other system whose movement, relatively to the first system, is a movement of pure translation with uniform velocity.

The validity of this principle of relativity cannot be doubted if we believe that all phenomena can be explained by the laws of mechanics. Even without this assumption it is evident that, if the principle of relativity in the strict sense were not true, certain phenomena which are referred to a system fixed relatively to the earth might be affected by the earth's rotation or its revolution around the sun. Not the slightest effect of this character, however, has been detected by the most delicate measurements, such as those of Michelson.

The principle of relativity in the strict sense, therefore, has stood the test of experiment. If it long seemed doubtful, and is still so regarded by some physicists, this is because it appears irreconcilable with the electrodynamical theories of Maxwell and Lorentz. In particular, the constancy of the velocity of light, which is deduced from those theories, seems difficult to admit.

If, for example, the ray of light and the observer are moving in the same direction with velocities V and v, it would seem that the velocity of the light, estimated from the observer's point of view, should be $V-v$.

An exact analysis of the physical meaning of our data of space and time proves that this contradiction is only apparent. "It rests," says Einstein, "on the two following arbitrary hypotheses: first, that the statement that two events occurring in different places occur simultaneously has a meaning independent of the system of reference; second, that the distance between the places in which two events occur simultaneously is independent of the system of reference."

If these arbitrary hypotheses are renounced, the constancy of the velocity of light becomes compatible with the principle of relativity. We may assume that a ray of light moves, *in vacuo*, with the same velocity relatively to any two systems of co-ordinates whose relative movement is one of uniform translation. We need only make a proper choice of the equations of transformation that connect the co-ordinates of space and time (x, y, z, t) of one system with the co-ordinates (x', y', z', t') of the other. These equations of transformation, called "Lorentz's equations," should replace the ordinary equations of transformation, which were used before the theory of relativity was developed, and which are based upon the arbitrary hypotheses mentioned above.

Thus the theory of relativity furnishes a condition which must be satisfied by all systems of equations that express general laws of nature. It does not furnish means of evolving natural laws hitherto unknown, but it gives a criterion of universal applicability which limits the possibilities. In this respect it resembles the principle of equivalence, Carnot's principle, and Curie's principle of symmetry.

Now there is one domain of fundamental importance in which our empirical knowledge is far too small to supply, even in conjunction with the principle of relativity, a firm basis for a general theory, so that the foundation must be completed by physical hypotheses. This domain is gravitation. It is sometimes said that the theory of relativity fails when it is applied to the explanation of gravitation, but the failure appears to be due to the dearth of experimental data. Einstein thinks, however, that the theory recently enunciated by

* Translated from A. Boutaric's *résumé*, in *La Revue Générale des Sciences* of Einstein's article in *Scientia*, May, 1914.

Nordstrom, which satisfies the principle of relativity, is an interesting tentative solution. In this theory the *weight* (regarded as a coefficient determining the force experienced by a body in a field of gravitation) of an isolated system, integrally at rest, is in general a fluctuating quantity, the mean value of which at any instant is given by the total energy of the system. Such a system would continually emit longitudinal waves of gravitation, but the loss of energy thus caused would be far too small to be perceptible.

II. THE THEORY OF RELATIVITY IN THE WIDER SENSE.

Orthodox mechanics and the theory of relativity in the strict sense do not suffice, in Einstein's opinion, to give a physical image of the universe that satisfies a mind open to philosophical arguments. For example: "We try in vain to explain what we mean by the acceleration of a body. We are able to define only relative acceleration, the acceleration of one body with respect to another. But, on the other hand, we found our mechanics on the hypothesis that a force (cause) is required to give a body an acceleration, forgetting that we cannot indicate what we mean by acceleration, because relative accelerations are the only ones that can be perceived."

Einstein, therefore, proposes to generalize the theory of relativity in a manner that will obviate the foregoing objection.

"In the first place, I admit that an absolutely fundamental part, in such a theory, must be assigned to universal gravitation. For, from the preceding remarks it follows that every physical process, because it involves quantities of energy, necessarily creates a field of gravitation. On the other hand, the observed fact that all bodies fall in the same manner in a field of gravitation suggests the idea that physical processes are accomplished in a field of gravitation as they would be accomplished relatively to an accelerated system of coordinates (the hypothesis of equivalence). Starting from this conception, I reach the conclusion that the velocity of light should not be regarded as independent of the gravitation potential. The principle of the constancy of the velocity of light, therefore, is incompatible with the hypothesis of equivalence, and, consequently, with the theory of relativity in the strict sense. Thus I was led to regard the theory of relativity in the strict sense as applicable only to regions in which there are no perceptible differences of gravitation potential. The theory of relativity in the strict sense should be replaced by a more general theory which includes it as a limiting case." It is difficult to give even a vague idea of this generalized theory of relativity, which necessitates the employment of the most recent advances in mathematical analysis. The theory enables us to replace the known equations of physics by other equations which are valid for all co-ordinates of space and time. These new equations contain quantities which Einstein denotes by the symbol $\zeta_{\mu\nu}$ and which represents the field of gravitation. This field affects all physical phenomena and is itself determined by physical processes. Hence, every physical process is regulated by the quantities $\zeta_{\mu\nu}$, which, in turn, are determined by the physical processes of the entire universe.

This theory is free from the philosophical objections mentioned above. In particular, the equations of motion of heavy masses contain, not absolute accelerations, but accelerations relative to other bodies, which are the only ones that can be observed.

Steering Vessels by Electricity

IN the proceedings of the American Institute of Electrical Engineers the subject of steering vessels by electrically operated gears was discussed by H. L. Hibbard, and a method for calculating the power required is given. The author gave a short account of the early designs, and a description of the recent equipment installed in American battleships. The following summing up of the features of steam and electrically driven gears covers the points discussed.

Among the disadvantages of modern steam steering gear the author mentions: (1) Long lengths of steam piping and lagging, and rises in temperature of spaces through which piping passes. (2) Wastage of steam, as steam steering gear takes full stroke, and the valve setting is often such that steam is always blowing through the engine. (3) The engine must be designed for the maximum work required of it, i. e., when rudder is at maximum angle. (4) Severe stresses on reciprocating parts due to sudden decrease of load when rudder goes back to central position. Mechanical connections from bridge to engine valve are a continual source of trouble.

Against these, the advantages of the electric drive are: (1) Reduction of weight and space occupied by driving mechanism. (2) Suppression of heat in compartments. (3) Elimination of accidents due to burst steam pipes. (4) Reduction of vibration and noise. (5) More efficient mechanism and the overload capacity of the motor can be used in extreme positions of the rudder. (6) Simplification of control from bridge. (7) Increase in rapidity and accuracy of response of the rudder to movements of the controlling mechanism.

Cable Conveyor System in Belgium

THE well-known Cockerill metallurgical establishment of Seraing, Belgium, has in use a cable transporter of the Beer system which ranks among the most extensive of the kind in Europe. The transporter works over 7,000 feet in length, and has a difference of level of 500 feet between start and finish. As much as 150 to 160 tons of material per hour is carried, and the suspended cars take a standard load of 1 ton each. On its way the line passes over houses and streets of the town, and on almost all the course it uses wire netting underneath to protect against any falling material. When at the end of the traject, the cars are automatically overturned to discharge the load, then pass over the cable and back to the starting point of the line for reloading. At present the transporting system is running day and night and is said to handle upwards of 3,000 tons of material per twenty-four hours.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

A Beam Which Is Made Stronger if It Is Apparently Weakened

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

It sounds strange that a beam of triangular cross section, as shown in Fig. 1, is strengthened by being apparently weakened.

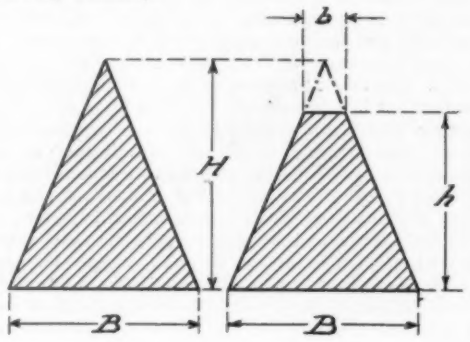


Fig. 1. *Fig. 2.*

The section modulus of a triangular cross section Fig. 1 is:

$$S = \frac{B \times H^2}{24}$$

if B represents the base, and H the altitude of the triangle.

If the apex of the triangle is cut off parallel to the base, as shown in Fig. 2, a trapezoid remains, the section modulus of which is:

$$S_1 = \frac{6b^2 + 6bb_1 + b_1^2}{12(3b + 2b_1)} \times h^2$$

in which b_1 represents B-b

To judge by the diagrams, one is inclined to think that the section modulus of the full triangular cross section is larger, but the contrary is the case; namely, if 13 per cent of the altitude of the triangle is cut away, the rest of the cross section has a larger section modulus, which exceeds the one of the triangular section about 10 per cent.

If $\frac{H - h}{H} = x$, hence

$$b = xB;\ b_1 = (1 - x)B;\ h = (1 - x)H.$$

These values inserted in the formula for S_1

$$S_1 = \frac{6x^2B^2 + 6x(1 - x)B^2 + (1 - x)^2B^2}{12(3xB + 2(1 - x)B)} (1 - x)^2H^2$$

or $S_1 = \frac{BH^2}{24} \times 2 \times \frac{x^4 + 2x^3 - 6x^2 + 2x + 1}{x + 2}$

or $S_1 = S \times K$

in which S represents the section modulus of the full triangular cross section and

$$K = 2 \times \frac{x^4 + 2x^3 - 6x^2 + 2x + 1}{x + 2}$$

New York. OTTO FRICKE.

Brazil and International Legal Time

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2005, of June of this year, I read, under the heading of "Legal Time in Various Countries," an article by Dr. M. Philippot, in which I noticed an important oversight and this is in your having omitted to include Brazil in the list of nations which have adopted the new system of official hour.

For the sake of an information and so that you may be well posted, I take pleasure in advising you that, contrary to what is stated in this article, in June of last year the Congress approved the law of "legal-hour" and, therefore, since the first of January, 1914, this law has gone in force for the ascertaining of the legal time, having the meridian of Greenwich as main basis.

In accordance therewith, Brazil was divided into four distinct sections, the first having as legal same as that of Greenwich less two hours, and the last section, the time is to be diminished five hours.

Therefore, since January, 1914, Brazil has adopted the official hour. This decision will no doubt facilitate in extent the commercial relations, for, as above mentioned, the whole of the Brazilian territory was divided into four sections.

Trusting this information will be of some value for your goodselves, I beg to remain,

Rio de Janeiro. CESAR ROBELLO.

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